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ABSTRACT

This report summarizes the data from a comparative study of grades 2 and 5 mathematics instruction and the use of Developing Mathematical Processes (DMP) in IGE and non-IGE settings. These results are part of a five-phase evaluation of the IGE system of elementary schooling. Use of DMP and reported adoption of IGE were not found to be good indicators of instructional patterns in mathematics. At both grades, the instructional emphasis was on computation, with insufficient time allocated to other important areas of mathematics, in particular problem solving at grade 5. Use of worksheets exclusively was found to be ineffective for increasing achievement. Use of manipulative materials was very effective for increasing achievement for some objectives. (Author)

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Working Paper 317

Mathematics Instruction in IGE and Non-IGE Schools

by Thomas A. Romberg, Deborah M. Stewart, Norman L. Webb, Anne G. Nerenz, Mary Pulliam, and Dinesh Srivastava

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Working Paper No. 317

MATHEMATICS INSTRUCTION IN IGE AND NON-IGE SCHOOLS

by

Thomas A. Romberg, Deborah M. Stewart, Norman L. Webb,
Anne G. Nerenz, Mary Pulliam, and Dinesh Srivastava

Report from the IGE Evaluation Project

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February 1982

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Abstract

This report summarizes the data from a comparative study of grades 2 and 5 mathematics instruction and the use of Developing Mathematical Processes (DMP) in IGE and non-IGE settings. These results are part of a five-phase evaluation of the IGE system of elementary schooling. Use of DMP and reported adoption of IGE were not found to be good indicators of instructional patterns in mathematics. At both grades, the instructional emphasis was on computation, with insufficient time allocated to other important areas of mathematics, in particular problem solving at grade 5. Use of worksheets exclusively was found to be ineffective for increasing achievement. Use of manipulative materials was very effective for increasing achievement for some objectives.

I

INTRODUCTION TO THE STUDY

This paper reports the results from one of two comparative studies which were a part of Phase IV of the Individually Guided Education (IGE) Evaluation Project. Phase IV was one of five related phases comprising an extensive evaluation of IGE. This report summarizes the data from a comparative study of mathematics instruction and the use of Developing Mathematical Processes (DMP) in IGE and non-IGE settings. These results should be seen as a part of a larger evaluation of the IGE system of elementary schooling.

An Overview of the Evaluation Project

Through the combined efforts of the Wisconsin Research and Development Center for Individualized Schooling, the University of Wisconsin IGE Teacher Education Project, the Kettering Foundation (I/D/E/A), and IGE coordinators in 25 states, more than 2,000 elementary schools have adopted a system called Individually Guided Education.

The purpose of the IGE Evaluation Project, which began in 1976, was twofold. First, we intended to evaluate IGE to gain a more comprehensive view of the system's operation and effectiveness. Second, we hoped to identify which features contribute most to the success of reading and mathematics instruction as a result of reform-change model, and to use the findings to study larger theoretical issues about instructional variables, curriculum planning, school change, etc.

The work of the project was separated into five phases. Phase I was a large sample study which provided basic information about IGE schooling. Certain features of IGE schooling were reputedly crucial to IGE success, and the purpose of Phase I was to examine the extent to which those features had been implemented in IGE schools and to assess the effectiveness of that implementation. Information was obtained from the staffs of approximately 155 IGE schools using self-report surveys and from students using standard paper-and-pencil instruments. The data were intended to provide a functional understanding of IGE features, processes, and outcomes by relating a broad scope of variables in an interpretative manner (Price, Janicki, & Romberg, 1980).

Phase II verified and extended the self-report data gathered in Phase I to include more fully the range of variables that determine the process of schooling (Ironside & Conaway, 1979).

Phase III focused on the social meaning which emerges as IGE is implemented on a day-to-day basis. The problem of understanding the impact of educational reform can be approached by viewing schools as social institutions whose characteristics shape and are shaped by the behaviors of their members. This focus allows us to think of a school as a complex social arrangement consisting of underlying patterns of conduct which channel thought and action within that setting (Popkewitz, Tabachnick, & Wehlage, in press).

Phase IV was designed to examine how effectively the three curricular programs (prereading, reading, and mathematics) developed for IGE meet their objectives and to investigate the relationship of instructional time and means of instruction to pupil outcomes.

Finally, the goal of Phase V is to synthesize the results of Phase I through IV and to address the significant issues in contemporary schooling raised by the project as a whole. Thus, each phase of the evaluation was designed to complement and strengthen the validity of the data gathered by the previous phases. For example, data on means of instruction, gathered by the large-sample study of Phase I, was examined in somewhat greater depth in fewer schools by the Phase II studies. Phase III's analysis developed a view of instruction from a different perspective. Phase IV explores means of instruction in reading and mathematics. Phase V was designed to integrate and interpret the data from all the preceding phases into a series of statements of the project's implications for educational issues.

Individually Guided Education

IGE is a complex system based on theoretic and pragmatic ideas about schooling, children's learning, and the professional roles of school staffs (Klausmeier, 1977). This system has seven components:

1. Multiunit organization
2. Instructional programming for the individual student
3. Assessment and evaluation for educational decision making
4. Curricular and instructional materials and activities for each child's instructional program
5. Home-school-community relations program
6. Facilitative environments for professional growth, and
7. Continuing research and development for system development

To relate these seven components, a descriptive framework was developed that considers outcomes of IGE as a function of both instructional means and the degree of implementation (Romberg, 1976). Four types of variables were identified to guide the evaluation of IGE: pupil and staff outcomes, means of instruction, support systems, and pupil and staff background. Figure 1 shows how the four types of variables were related.

1. Pupil and staff outcomes, and the extent to which these outcomes have been attained, should be the initial basis of an IGE evaluation. Both pupil and staff outcomes are illustrated in Figure 1 as being multivariate and multilevel. In this study, a set of curriculum-specific pupil achievement scores in reading was used.

2. The instructional means of formal schooling must be a second basis for an evaluation of IGE. It has been fashionable in evaluation circles to concentrate on ends or outcomes and to ignore the means by which they are reached. Reform movements, such as IGE, invariably attack the properties of means. To this extent judging the value of the means is as important as assessing outcomes.

The means of instruction considered in the evaluation project were separated into three sets of activities based upon the operating characteristics of IGE schools: staff activities of the Instructional Improvement Committee (IIC) and the Instruction and Research Units (I & R Units), activities of the staff teacher both in curriculum management and pupil interactions, and activities pupils related to reading and mathematics instruction.

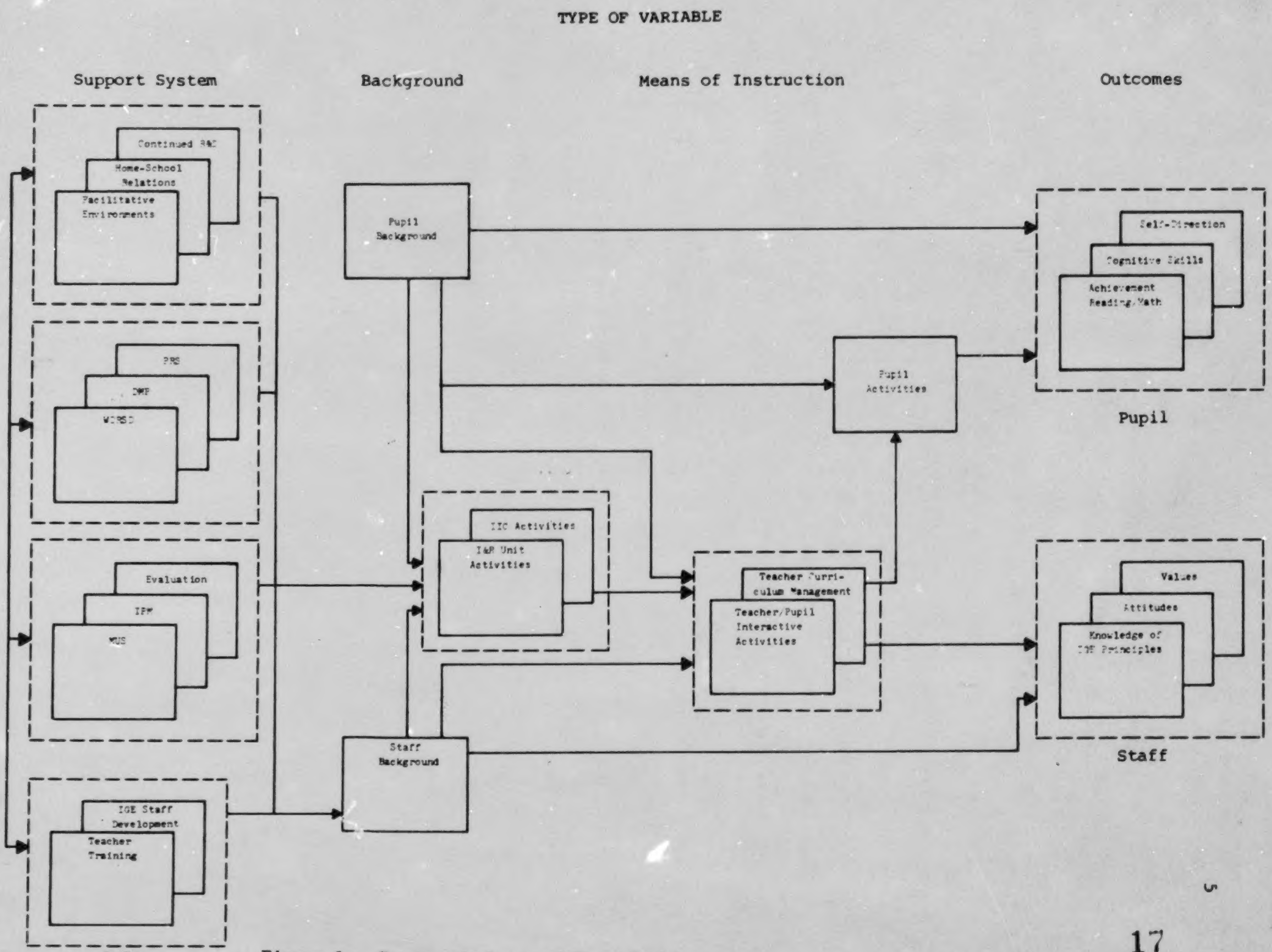

TYPE OF VARIABLE
Support System
Background
Means of Instruction
Outcomes
Continued R&D
Home-School Relations
Facilitative Environments
PRS
DMP
WIRSD
Evaluation
IPM
MUS
IGE Staff Development
Teacher Training
Pupil Background
Staff Background
IIC Activities
I&R Unit Activities
Teacher Curriculum Management
Teacher/Pupil Interactive Activities
Pupil Activities
Self-Direction
Cognitive Skills
Achievement Reading/Math
Pupil
Values
Attitudes
Knowledge of IGE Principles
Staff

Figure 1. Framework for an IGE evaluation.

3. Both pupil and staff backgrounds are shown influencing means of instruction and outcomes. Also, staff background is in turn influenced by training in the support systems. For pupil background, both initial achievement and demography data were collected.

4. The degree and manner in which support systems of IGE have been incorporated and developed in a school must be judged. The seven components of IGE have evolved as practical ways of supporting new instructional methods, which in turn produce desired pupil and staff outcomes. It can be argued that the efficiency of an IGE school depends upon the components implemented and the manner in which they are operating.

The support systems for an IGE learning environment were separated into four categories as indicated in Figure 1. The second category, curricular materials compatible with instructional programming and evaluation (IGE Component 4), is shown by identifying the three major curricular products developed for IGE, the *Wisconsin Design for Reading Skill Development* (WDRSD) (Otto, 1977), *Developing Mathematical Processes* (DMP)(Romberg, 1977), and the *Pre-Reading Skills Program* (PRS) (Venezky & Pittelman, 1977). The functional relationships illustrated in Figure 1 convey the following premises: (a) the degree to which IGE support systems have been implemented, together with pupil and staff backgrounds, directly influences the means of instruction in an IGE school; and (b) the means of instruction, along with pupil and staff backgrounds, account for pupil and staff outcomes.

Although much has been written about the conceptual background of IGE, no comprehensive picture now shows how IGE has been implemented in elementary schools. Thus, the IGE Evaluation Project was designed to gain a more comprehensive view of the system's operation and effectiveness. The desired outcome is to identify which features contribute most to the success of reading skills and mathematical instruction as a result of individualized schooling.

Overview of Phase IV

The intent of Phase IV was to describe in considerable detail the actual operating characteristics of a sample of schools which were using curriculum materials designed to be compatible with IGE. Phase IV was restricted to the investigation of three groups of variables--pupil outcomes, instructional time, and means of instruction--in IGE and non-IGE settings in which the Center's curriculum programs as well as alternative curriculum materials were being used. Pupil attainment of program objectives is the main variable. The other two variables, instructional time and means of instruction, are essential in explaining and understanding how the programs work and how objectives are attained. These two variables are also important from a practical point of view because they can be manipulated by teachers. Describing the use of each program in terms of allocated time, engaged time, and instructional activities provides concrete factors that teachers can work with (Webb & Romberg, 1979).

In addition, instructional time was included because of recent studies and reviews that stress its importance and its relationship to pupil outcomes (Harnischfeger & Wiley, 1975; Rosenshine, 1977; McDonald & Elias, 1976; Fisher et al., 1975). As Harnischfeger and Wiley state, "All influences on pupil achievement must be mediated through a pupil's active and passive pursuit" (1975, p. 15). Certainly, there is enough evidence to suggest that instructional time is an important measure of pupil pursuits. Its use as a variable in Phase IV, then, had two purposes. First, the amount of time during which students are actively engaged in learning when using one of the three programs is a means of describing how the programs are being used. The assumption is that the programs should maximize student engagement by attending to the individual's needs. Second, Phase IV provided an excellent opportunity to study in more detail the relationship of pupil outcomes to instructional time.

In summary, the primary purposes of Phase IV were:

1. to determine the degree to which WDRSD and DMP meet their goals of having students master specified objectives and skills
2. to determine how time is allocated for instruction in implementing WDRSD and DMP
3. to relate instructional time to the means of instruction and mastery of content for WDRSD and DMP, and
4. for each curriculum program, WDRSD and DMP, to contrast two situations--IGE schools using the program with non-IGE schools using the program and IGE schools using the program with IGE schools using alternative programs--on the variables of pupil outcomes, instructional time, and means of instruction

Five studies were conducted as part of Phase IV, three descriptive studies and two comparative studies. The descriptive studies were small sample studies designed to describe how the curriculum programs DMP, WDRSD, and PRS were being used in IGE schools. The studies were conducted during the winter and spring of 1978 at two IGE schools using DMP (Webb, Nerenz, Romberg, & Stewart, 1980), two IGE schools using WDRSD (Nerenz, Webb, Romberg, & Stewart, 1980), and three IGE schools using PRS (Stewart, Nerenz, Webb, & Romberg, 1980). The two comparative studies also focused on the use of WDRSD and DMP in IGE settings. This report is on the use of WDRSD.

Model for Phase IV

A structural model for predicting student achievement was developed for Phase I (Price, Janicki, Howard, Stewart, Buchanan, & Romberg, 1978) from the three premises on which IGE is based:

1. Certain organizational features make it more likely that certain desirable instructional practices will occur. These organizational features also make it more likely that the staff will be satisfied with their jobs.
2. The use of certain curriculum materials and associated systems of information collection and record keeping makes it more likely that certain desirable instructional practices will occur.
3. Those instructional practices which are deemed desirable in IGE make high student achievement more likely. They also make it more likely that desirable changes in other student characteristics, such as self-perception and locus of control, will occur.

Phase IV was designed to provide more detail on the last two premises posed in Phase I, with specific attention paid to means of instruction and curriculum-related student achievement, while providing sufficient background information that each school in the smaller Phase IV sample might be related on several significant dimensions to the findings of the larger Phase I sample. Thus, some information was collected on five of the six school-wide variables used in Phase I--General Implementation of the Intructional Programming Model (IPM), Intraorganizational Structure (IOS), Procedures Fostering Coordination and Improvement of the School Program (GOS), Interorganizational Relations (IOR), and General Staff Background (GSB). In Phase IV the Program Use variables--Curriculum Implementation and Program Customizing--included the kinds of information provided in the Phase I curriculum-specific variables. More detailed information about classroom procedures and achievement outcomes was also collected in Phase IV. A model depicting the Phase IV variables and the anticipated relationships is shown in Figure 2.

Four groups of variables are shown in Figure 2--school background, curriculum program use, classroom activities, and pupil outcomes. As stated above, the school variables, which were assessed through structured interviews with school staff, provide a link between the Phase IV sample and the larger Phase I sample. Curriculum program use variables, also measured through structured interviews, have a linking function to Phase I and provide a descriptive background for the measures of classroom procedures. These procedures were assessed through logs maintained by teachers for selected students and through observations in the classrooms; means of instruction and the use of instructional time are detailed measures of how programs are used in classrooms and related directly to pupil attainment of objectives. Pupil outcomes were specified in terms of specified objectives of DMP and were assessed through achievement monitoring procedures.

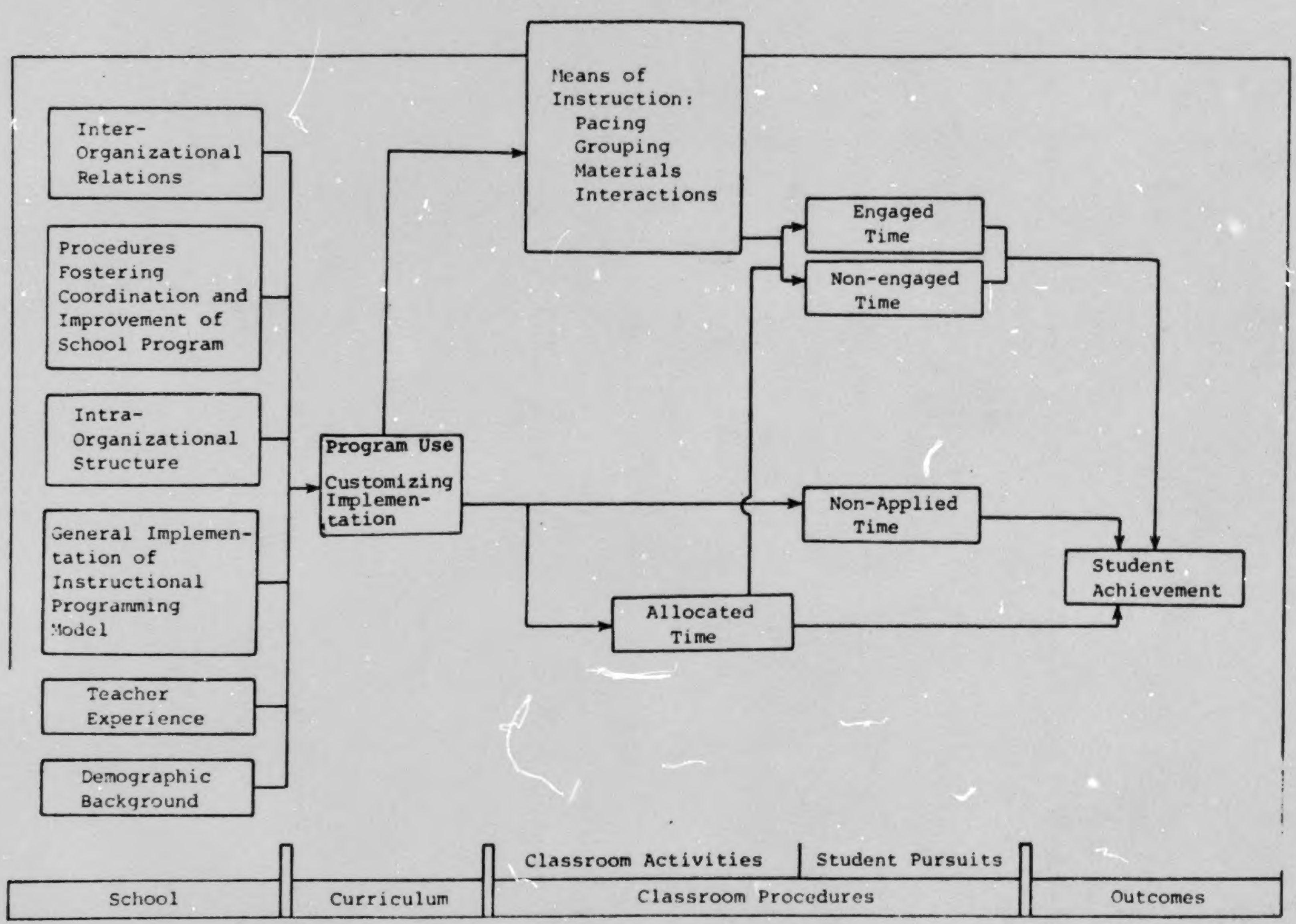

Inter-Organizational Relations
Procedures Fostering Coordination and Improvement of School Program
Intra-Organizational Structure
General Implementation of Instructional Programming Model
Teacher Experience
Demographic Background
Program Use
Customizing Implementation
Means of Instruction:
Pacing
Grouping
Materials
Interactions
Engaged Time
Non-engaged Time
Non-Applied Time
Allocated Time
Student Achievement
Classroom Activities
Student Pursuits
School
Curriculum
Classroom Procedures
Outcomes

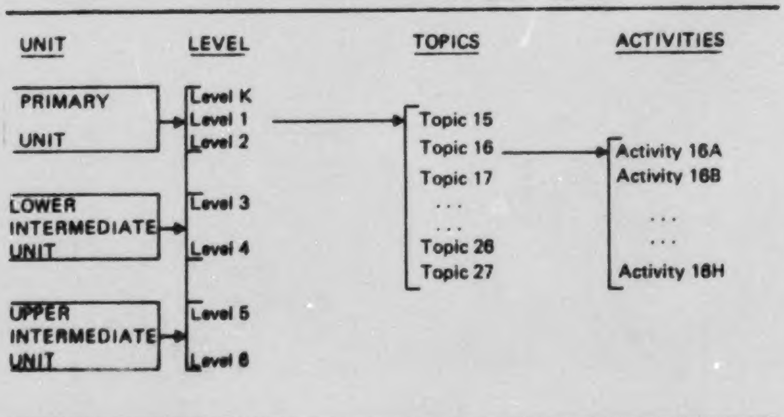
Figure 2. Phase IV model of anticipated relationships between variables (Romberg, Webb, Stewart, & Nerenz, 1980, p. 24).

The DMP Program

In order to better understand the data gathering procedures used in this study, a brief introduction to Developing Mathematical Processes (DMP) (Romberg, Harvey, Moser, & Montgomery, 1974, 75, 76) may be helpful. DMP is a total program of elementary mathematics for grades K-6 developed to be compatible with the IGE instructional programming model. It is organized in the following way. Activities designed to promote attainment of closely related objectives have been clustered to form 90 topics. These topics have been grouped into units for purposes of organizing materials and facilitating continuous progress of children. To provide for ease in ordering and storing materials, the units have been divided into levels that approximate one school year of study. Table 3 indicates the organization of the materials. The organization of Level 1 has been expanded to indicate the manner in which topics and activities are labeled for reference purposes.

Table 1

Organization of DMP by Unit, Level, Topics, and Activities


UNIT
LEVEL
TOPICS
ACTIVITIES
PRIMARY UNIT
LOWER INTERMEDIATE UNIT
UPPER INTERMEDIATE UNIT
Level K
Level 1
Level 2
Level 3
Level 4
Level 5
Level 6
Topic 15
Topic 16
Topic 17
...
...
Topic 26
Topic 27
Activity 16A
Activity 16B
...
...
Activity 16H

The components of DMP are resource manuals, teacher's guides for each topic, student booklets and guides, printed and physical material kits, a preassessment package, topic inventories, and pupil performance records.

DMP approaches mathematics through the measurement of attributes. The major content areas are problem solving, place value, attributes, measurement, addition and subtraction, multiplication and division, fractions, geometry, and statistics. An emphasis is placed on exploring relationships between objects using processes such as describing, classifying, ordering, equalizing, joining, separating, grouping, and partitioning.

As shown in Figure 3, a sequence of activities is specified within each topic. Alternate activities are included for students who need more work on an objective or provide a variation in instruction or challenging problems. The activities are keyed to objectives. The topic inventories are used to assess mastery of the objectives for each topic. Instructional activities include experiments, use of manipulatives, learning stations, games, stories, discussions, worksheets, and contests.

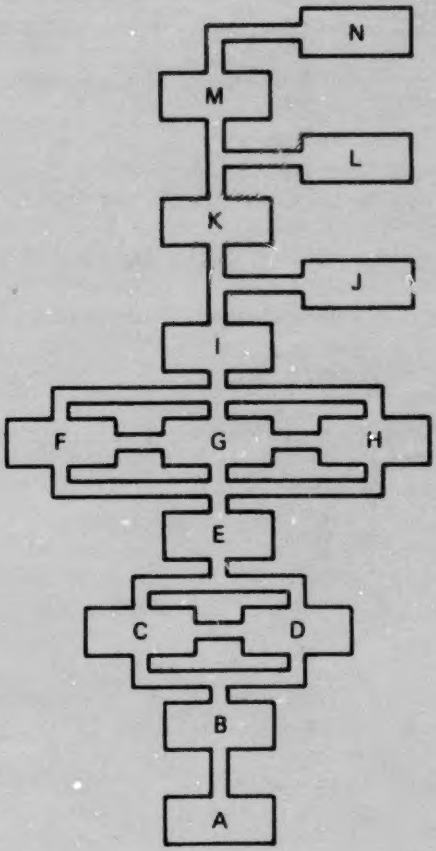

N
M
L
K
J
I
F
G
H
E
C
D
B
A

Figure 3. Suggested sequence chart for DMP Topic 23. (Adapted from Romberg, Harvey, Moser, & Montgomery, 1974.)

II

Design of the IGE/DMP Comparative Study

Details of this study of mathematics instruction in IGE and non-IGE schools are described in this chapter. Included are the research questions to be examined; the basic design of the study, including the sampling procedure used; how the data were collected, aggregated, and scaled; and the analysis plan.

Research Questions

As discussed in Chapter I, this study examined three primary research questions.

1. What are the effects on mathematics instruction of using the DMP mathematics program in an IGE and a non-IGE school environment?

To answer this question, data were gathered from a sample of IGE schools using DMP and a similar sample of non-IGE schools using the same program.

2. What are the effects on mathematics instruction of using DMP and using other mathematics programs in the IGE school environment?

To answer this question, data from the sample of IGE schools using DMP used to answer question 1 and data from a sample of IGE schools using other mathematics programs were gathered.

3. What are the relationships between the variables presented in Figure 2?

To answer this question, data from the total sample of schools used to examine the first two questions was utilized. The diagram in Figure 2 could be considered a structural design, path diagram, or causal model. Ideally, if each of the variables specified in the diagram was scaled, a set of structural equations corresponding to the model could be written. Then these equations could be statistically examined for their agreement with the data collected in the Phase IV study. Within the limits imposed by measurement error in the procedures used to collect the data, this approach would test the theoretical model. Unfortunately, although this structural analysis was planned, it could not be carried out. The small number of cases coupled with difficulty in scaling some variables (leading to several separate variables--in particular, a larger set of student achievement variables) and disagreement on the existence (or non-existence) of some relationships (paths) made such an analysis unfeasible. Instead a two stage multiple regression analysis was carried out. For the first stage, student engaged times on content objectives were used as the dependent variables and the classroom activities, curriculum, and school variables were entered as independent variables. At the second stage, student achievement scores were used as the dependent variables and the student pursuit variables were then added to the other variables.

Operationally, there were three problems associated with answering these questions. First, reasonable samples of schools had to be recruited for the study so that appropriate comparisons could be made. The sampling plan is described later in this chapter. Second, since the schools differed only in "labels" for their instructional environment (IGE or not) or their mathematics program (DMP or not), and since we knew schools varied in their degree of commitment and manner of use with regard to both IGE and DMP, some data were needed to demonstrate that the labels reflected actual operational differences. Third, we needed to aggregate and scale the variables associated with mathematics instruction. Details of how this was done follows in this chapter.

The Basic Design of Mathematics Comparative Study

Data were gathered for this Comparative Study from October until May during the 1978-79 school year. As described, three types of schools were included in the study:

1. IGE schools using DMP
2. Non-IGE schools using DMP
3. IGE schools not using DMP

Data were collected only from students in Grades 2 and 5 and their teachers in those schools. Data were collected by four means: tests on general objectives of DMP, observations of specific students during the mathematics instructional period, teacher logs for mathematics instruction of specific students, and questionnaires which served as the basis for structured interviews with school staff.

Sample. Three DMP triads of schools were identified to participate in this study. Each triad was to have one school of each of the three types. Schools within each triad were matched according to location, socio-economic level, composition of student body, size, and, for the IGE schools, "IGE-ness." The same demographic categories used in Phase I (Price, et al., 1978) were used to classify the communities in which the schools were located:

1. Extreme rural--community with a population under 3,500 where most of the residents are farmers or farm workers
2. Small place--community with a population of less than 25,000
3. Medium city--city with population between 25,000 and 200,000
4. Main big city--community within the city limits of a city population over 200,000 and not included in the high or low metro groups
5. High metro--area in city with a population greater than 150,000 where a high proportion of the residents are in professional or managerial positions
6. Low metro--area in city with a population greater than 150,000 where a high proportion of the residents are on welfare or not regularly employed
7. Urban fringe---community within the metropolitan area of a city with a population greater than 200,000 outside the city limits and thus not in the high or low metro groups

The three triads of schools in the DMP study represented extreme rural and small place, medium city, and urban fringe. One medium city IGE school using DMP withdrew from the study just prior to the beginning of the data collection. Thus, the medium city group was reduced to two schools, an IGE school not using DMP and a non-IGE school using DMP, bringing the number of schools in this study to eight.

Data collection. Four procedures were used to collect data from second- and fifth-grade pupils and teachers in the eight schools.

Pupil outcomes were measured using an achievement monitoring procedure with item sampling. The DMP program contains topics of instruction related on the IGE instructional programming model (IPM). Once a pupil has mastered the objectives of a topic, he or she is to be regrouped with the other pupils with similar needs and given instruction on a new topic. The instructional sequence of topics should vary from pupil to pupil. Because of this variation in the instruction which pupils receive, an achievement monitoring procedure with tests administered at eight points during the school year was chosen to provide information on the attainment of objectives. Such a procedure is more sensitive to the individualization of the programs than other designs, such as pre- and posttesting.

The tests used in the IGE Descriptive Studies (Webb & Romberg, 1979) were refined for use in the Comparative Studies. The tests were compiled by identifying 12 DMP objectives in Grade 2 and 14 DMP objectives for Grade 5. One to four items for each of the DMP objectives were then prepared to form an item pool for each grade level. Items from each pool were distributed among four forms using an item sampling technique. All achievement monitoring test items were constructed in a multiple-choice format and used terminology which would be understood by pupils in programs other than the curriculum under consideration.

The achievement monitoring tests were administered eight times during the school year. The pupils at each grade level were divided at random into four groups and the four test forms at each level were rotated among the groups so that each group was given a different form of the test for any two consecutive administrations and, over the school year, each student took each form twice. The maximum time for any one testing for a student was 50 minutes.

A second testing procedure was used to measure achievement on three specific math objectives at each of the two grade levels at the eight schools participating in the mathematics study. Domain-referenced tests were administered three times--at test time 1 (October), at test time 4 (January), and at test time 8 (May). This procedure was used in order to test key objectives in more detail and to provide a measure of pupil outcomes on the general concepts and ideas associated with the objective domain as well as specific skills needed to perform the individual items. For example, for the Grade 2 objective of counting objects in sets from 0-99, the analysis of the domain-referenced tests provided measures of the ability of the group of pupils to count the objects as well as the pupils' specific problems in counting objects grouped in different ways (e.g., by fives, sixes, and tens).

For each of the three test times the domain-referenced tests were administered, a set of ten items was randomly chosen from the specified domain of items for each of the three objectives for the grade level. All items were open ended and required the pupils to supply the answer in order to minimize guessing. The Harris-Pearlman (1978) procedure was used to separate the item difficulty into two factors, one representing the domain difficulty and the other representing difficulty with the specific item. Also, since all students took the same tests, the domain-referenced tests can be used to compare the representativeness of the outcomes of the target students to the group from which they were selected. The testing time for the domain-referenced tests was approximately 40 minutes. However, results from these domain-referenced tests are not included in this analysis.

Observations were carried out using the same system as in the Phase IV Descriptive Study (Webb & Romberg, 1979). Initially, six target students were randomly identified in the unit or class. The target students changed over the year, since in some IGE situations students are regrouped periodically, making it physically impossible to observe the same six students. The target students were observed in sequence using a time sampling procedure. The first student was observed for a moment and his or her activity was coded. Then the next target student was observed for a moment and his or her activity coded. The procedure continued until all six target students had been observed, taking approximately 3 minutes. Thirty seconds were then taken to record the major role of the teacher(s) and general activites occurring in the classroom. This cycle was repeated, observing each target student in sequence and recording general comments, during the time allocated for work on the curriculum program.

Seven major categories of data were coded:

1. General content--time devoted to other than the curricular program being observed
2. Specific content--math objective or reading skill
3. Pace--whether or not the student is working at his or her own pace
4. Grouping--size of group of which the student is a member

5. Materials--the materials being used by the student
6. Learner moves--student engagement or non-engagement
7. Interaction--persons with whom the student is interacting and the direction and focus of that interaction

The event occurring at that moment the target student was observed was characterized by checking subcategories under each of these main categories. This observation system was used to provide measures of the amount of time spent in general content areas such as waiting, transition, and management and, for specific content areas in mathematics, measures of the amount of time spent by students with different types of engagement.

The observers were trained to use the observation system in a four-day training workshop held in Madison in October 1978. The first day of the workshop was spent reviewing the materials and procedures used in each of the programs and explaining the observation system. Then the observers spent three days at a school doing observations and discussing the coding procedures. Percentage agreement on individual events and intercoder reliabilities on sums over events were calculated to assess the level of proficiency the observers had attained in using the observation procedures (Webb, 1979). In addition, a sample of schools was visited during the year to check the percentage agreement and intercode reliability. The observers returned for a two-day retraining session in February 1979, most of which involved observations in schools to check on the intercoder reliabilities.

Teacher logs were kept by the teacher who was directly responsible for the mathematics instruction of the students in the target population. These logs were kept daily for six to eight students, including those students being observed, in order to obtain a measure of the total time allocated to instruction on specific objectives over the investigation period. On the logs the teachers recorded the amount of instructional time allocated to specific mathematics objectives, the group size, and type of materials used during instruction.

Interviews were conducted in each school by the observer for that school with members of the Grade 2 and Grade 5 instructional staff and with the principal. Background information about the school, the staff, and use of the mathematics curriculum products was obtained from these interviews. The questionnaires used as the basis for the interviews were developed from two sources: the Phase I survey instruments and the curriculum developers' questionnaires about product use.

Instructional staff provided information about their own teaching experience, how the curriculum product was used, and how the overall instructional program was planned and carried out. Each principal described the school's organization, its relationship to other educational agencies, and some procedural aspects of the school's ongoing operation.

Data Aggregation and Scaling

Literally millions of separate pieces of information were gathered about mathematics instruction in the schools in this study. The aggregation of this mass of data into scaled variables was no easy task. The model given in Figure 2 (Chapter I) had five general categories of variables (school, curriculum, classroom activities, student pursuits, and pupil performance). Then within each category one or more general variables was specified (13 in all). However, the actual number of variables into which the raw data was aggregated was considerably more than 13 for four reasons. First, all classroom and performance data had to be aggregated separately for Grades 2 and 5 in each school. Second, for some general variables (like means of instruction), specific subcategories (like pacing, grouping, materials, and interactions) had to be considered as separate variables. Third, student achievement in mathematics was considered to be multidimensional. Pupil performance on specified program objectives was gathered, which led to aggregation of performance data into 23 general content objectives for mathematics (11 at Grade 2 and 12 at Grade 5). However, the related time variables (allocated time, engaged time, and non-engaged time) were also aggregated with respect to the same categories. Fourth, since data were gathered at several points in time, all of the data could also be aggregated in terms of when it was gathered.

The content aggregation for mathematics instruction was used with the teacher logs, classroom observations, and achievement monitoring tests. The data were grouped for analysis at three progressively more specific levels, the most inclusive being the "content area" followed by the "general objective" and the "specific objective."

For purposes of this study we organized the mathematical objectives into eight content areas: Place Value and Numeration, Operations (whole numbers), Fractions, Decimal Fractions, Measurement, Problem Solving, Geometry , and Miscellaneous. Within each of these content areas at each grade, from one to three general objectives were developed for the present study. The general objectives were based on the specific objectives of DMP. It should be noted that while the same content areas are used for both grades the general and specific objectives differ.

The aggregations for Grades 2 and 5 are as follows: (See Nerenz & Webb, 1980a, for details.)

Grade 2— place value and numeration. The content area includes three general objectives: Writing Numbers, Inequalities, and Other Place Value or Numeration. The Writing Numbers objective requires students to count the number of objects in a set and then write or recognize the appropriate numeral. Specifically, it includes compact, grouping, and expanded notations. The Inequalities objective focuses on ordering whole numbers, usually in sets of three, using appropriate symbols. Other Place Value or Numeration objectives include any other objectives asking students to identify and specify place values, count, or write the numerical value of sets of objectives or measurements.

Grade 2— Operations. The operations content area focuses on the manipulation of whole numbers using addition/subtraction or multiplication. For each of these two general objectives, children were to solve open sentences or to compute sums, differences, or products given two or more numbers to be added, subtracted, or multiplied. The numbers used in all computations ranged for 0 to 100.

Grade 2— Fractions. This content area and its general objective require the student to understand the basic concept of a fraction. Specifically, children are to identify a fractional part of a set or area and to use fractions in other elementary contexts.

Grade 2— Decimal Fractions. This general objective includes all objectives that involve decimal fractions. The general objective is not subdivided into specific objective levels since decimals are generally not taught at Grade 2.

Grade 2— Measurement. Measurement includes objectives that involve the assigning of a standard measure to a physical object or picture. The two dimensions of measurement which are included in this area are length and capacity.

Grade 2— Problem Solving. This content area includes two objectives--Word Problems and Applications--in which students were asked to find the solution to a verbal or pictorial problem. Word problems were stated in two or three units and could be solved by writing and then solving a mathematical sentence. Word problems were mainly restricted to one-step problems requiring the student to add or subtract two numbers. Unlike word problems, applications problems require the student to apply and combine different computing skills and more than one operation and step is generally necessary.

Grade 2— Geometry. Objectives concerning geometric shapes, movement or direction on a grid, and transformation of figures are included in this general objective.

Grade 2— Miscellaneous. This general objective includes any objective that cannot be classified under one of the other general objectives, such as time and money.

Grade 5— Place Value and Numeration. This content area includes all objectives related to place value, counting with whole numbers, using different notational forms (compact, grouping, and expanded notation), and number theory (primes, odd, even, lowest common denominator).

Grade 5— Operations. The Operations content area focuses on three general objectives: Addition/subtraction, Multiplication, and Division. The objectives included in this content area require students to apply computational algorithms and recall basic facts. The objectives include finding sums with numbers from 0-99,999, finding the difference of 3- to 5-digit numbers, finding products up to 999,999, and dividing 3-digit numbers by 2-digit numbers.

Grade 5—Fractions. The Fractions content area includes objectives pertaining to fractions in a ratio form $(\frac{a}{b})$. The content area is divided into two general objectives. The Concept area includes general understanding and representation of equivalent forms, and ordering of fractions. The Computes general objective includes solving addition, subtraction, and multiplication sentences involving fractions.

Grade 5—Decimal Fractions. The Decimal Fractions content area involves fractions in decimal form. The two general objectives focus on concepts and computations with decimal fractions. The Concept general objective includes finding an equivalent decimal form for common fractions. The Computes general objective includes finding the product of a whole number with a decimal, finding a sum of two or more decimal numbers, and finding a difference using two decimal numbers.

Grade 5—Measurement. All objectives dealing with measurement (lengths, areas, and volumes) are included under the general objective.

Grade 5—Problem Solving. The Problem Solving content area includes objectives that are divided into two general areas. Word Problems require students to solve problems that are generally stated in two or three lines and whose solution can be found by writing and then solving a sentence. Applications require students to apply or combine different computing skills in solving problems and usually require more than one operation or step.

Grade 5—Geometry. All objectives relating to geometry are classified under this content area, including objectives regarding geometric shapes, movement or direction on a grid, or the transformation of figures.

Grade 5—Miscellaneous. The miscellaneous content area includes any objective that cannot be classified under one of the other content areas. The area is subdivided at the specific objective level into two classes of objectives. Other Computations include objectives where students are asked to compute averages or percentages and to use processes which are not directly related to the objectives under the Operations content area. Other Miscellaneous includes such objectives as numeration systems, number theory, or graphs and tables.

Both log allocated time and observed times were aggregated separately for each grade for 11 and 12 general objectives, and then reaggregated according to the eight content areas. Achievement data, however, were gathered only on seven of the content areas at each grade (see Webb & Nerenz, 1980b). At Grade 2, objectives for decimal fractions were not measured, and at Grade 5, objectives for place value and numeration were not measured. These differences reflect the change in emphasis in mathematics between Grades 2 and 5.

The potential number of variables is dramatically increased because of the repeated measures design of the study. All pupil performance data were gathered eight times during the year, teacher logs were kept, and classroom observations occurred in all the periods between test times (see Figure 4). Thus, eight different sets of achievement data and seven different sets of observational data were available for analysis. However, for several reasons, it was decided not to analyze the data at this level of detail. These reasons included lack of resources, lack of support for distinctions between types of schools (see Chapter III), and a failure to discern meaningful patterns in the achievement data (Webb & Nerenz, 1980b). For this report, only achievement data from Test Time 8 (adjusted for Test Time 1 differences) are presented.

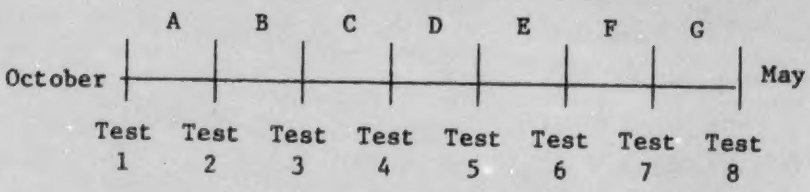


Figure 4. Observation periods and test times for the study.

All the teacher log and classroom observation data were aggregated over the seven observation periods into school year totals. Admittedly this aggregation obscures the fluctuations in content emphasis that occur during a year. However, the patterns of emphasis (allocated times to various general content objectives) appear not to be associated with IGE or use of DMP (Nerenz & Webb, 1980b).

The actual variables used in this study are as follows:

Student Achievement. Residualized mean gain scores (Test 8 adjusted for differences on Test 1) were calculated for 14 variables at Grade 2 and 16 variables at Grade 5 (see Table 2). This set of scores for each school appears in Appendix A.

Student Pursuits. Time was used as the unit for describing student pursuits. The observed number of minutes coded for the sample of children was used as the measure of four categories of variables at each grade level: non-applied time, available time, engaged time, and non-engaged time.

Table 2

Student Achievement Variables for the IGE/DMP Comparative Study

General Objective	Grade 2	Grade 5
01 Writing Numbers	✓	
02 Inequalities	✓	
03 Other Place Value or Numeration	✓	
Place Value and Numeration	01+02+03	
04 Addition/Subtraction	✓	✓
05 Multiplication	✓	✓
06 Division		✓
Operations (Whole Numbers)	04+05	04+05+06
07 Concept	✓	✓
08 Fractions Computes		✓
Fractions	07	07+08
09 Decimal Concept		✓
10 Decimal Computes		✓
Decimal Fractions		09+10
11 Measurement	✓	✓
12 Word Problems	✓	✓
13 Applications	✓	✓
Problem Solving	12+13	12+13
14 Geometry	✓	✓
15 Miscellaneous	✓	✓

Non-applied time is that time within the designated skills period spent in activities which are unrelated to reading skills or to math. This includes time spent in transition, waiting, management, break, or other academic or nonacademic content area. These six types of non-applied time were aggregated into three subvariables: undirected time (transition, waiting), supervised time (management, break), and other content (other academic or nonacademic content) for each grade level.

Available time equals the total amount of observed time less the non-applied time and thus is that portion of the instructional period which remains once undirected, supervised, and other content time have been subtracted. As indicated by the variable name, it is the time which is actually available for mathematics instruction. The total minutes and percentages of available time were reported in terms of the 15 content variables at each grade level.

Engaged time is that portion of the instructional period during which students are actively involved in learning the particular content. When summed, engaged time and its complement, non-engaged time, equal available time. Total minutes and percentage of engagement or non-engagement are reported as the aggregated variables for each of the content categories for mathematics at each grade level. In creating these variables, the three types of coded engaged student behavior (engaged-writing, engaged-oral, engaged-covert) were summed. Similarly, total non-engagement was created by summing the three categories of non-engaged behavior (non-engaged writing, non-engaged interim, non-engaged off-task).

Classroom activities. Time was also used as the unit for describing classroom activities. There are two categories of variables, allocated time and means of instruction, and both were measured using teacher log data and observational data.

Allocated time is the amount of time in minutes which is designated for instruction in mathematics; it represents the total amount of planned instruction for the 25 weeks. In each school, teachers recorded this information in logs. The time allocated by these logs was aggregated into the content categories for mathematics at each grade level. A proportion of all allocated time was observed in each school. These observations were used to check the validity of the teacher's estimates of allocated time.

Means of instruction includes the teaching procedures and materials used to implement a curriculum program and convey subject matter to the learner. Four types of information were coded for each of the content categories at each grade.

Pacing included either self-paced activities or other-paced activities. Pacing correlated so highly with Grouping in the Descriptive Study no separate data for Pacing was tabulated for this study (Nerenz, Webb, Romberg, & Stewart, 1980).

Grouping included one of three group sizes on the teacher logs: individual, small group (8 or fewer), and large group. On the observation forms, data on student groupings were coded into one of four categories: individual, pair, small group (fewer than 8), and large group. However, because pair and small group activities were rarely observed, these two categories were combined, resulting in the same three grouping categories that were used on the teacher logs.

Materials used during instruction were recorded on the teacher logs and the observations. On the teacher logs, four types of materials were considered: DMP, text or other curriculum series, teacher-made, and other. Seven categories of materials were considered on the observation forms: paper/pencil, manipulative, game, audiovisual, printed material, other, and can't tell. Because very little time was observed in the audiovisual, other, and can't tell categories, these were aggregated into a single subvariable. Manipulatives and games were also merged to form a single subvariable.

Interactions between the target student and the teacher, other adults, and other students were recorded by the observer. These categories were combined into two: student to teacher (or other adult) and teacher (or other adult) to student.

Curriculum. Two variables were created to characterize the use of the mathematics program, DMP, in schools: curriculum implementation and program customizing. Both are school variables estimated for each grade level. Data came from interviews with school staffs.

Curriculum implementation is a measure of the extent to which DMP is used. To develop a curriculum implementation scale, points were given for use of DMP as the main program, the variety of materials which were used and the use of pupil performance cards. To derive a total score for each grade level, scores for each teacher were summed and an average found (see Nerenz, Stewart, & Webb, 1980 for details).

Program Customizing is a measure of alterations made to meet the specific needs of individual students. Three aspects of customization were measured: adaptations to children's instructional needs, provision for review and reinforcement, and teacher development of materials. Adaptations were defined as changes, additions, and deletions in the curriculum program, and two facets of program adaptations were considered. The first is whether the program is adapted to meet instructional needs. The second is whether the existence of multiple instructional programs leads to duplication of instruction. Points obtained for these two responses were summed for each teacher. Provisions for review and reinforcement were considered to be an essential aspect of program use. Points were assigned if provisions for reviewing objectives were reported. Also, teacher development of materials was assigned one point if a teacher indicated preparation of special materials.

Subscores for customizing were summed for each teacher and averages were calculated for each grade level in each school. Possible values ranged from -3 to 9 (Nerenz, Stewart, & Webb, 1980).

School. As described in the IGE Evaluation Project, it was assumed that certain organizational features would make it more likely that certain desirable instructional practices will occur (Romberg, 1976). Data related to this premise were organized into five variables: Interorganizational Relations, Procedures Fostering Coordination and Improvement of the School Program, Intraorganizational Structure, General Implementation of the Instructional Programming Model, and Teacher Experiences. These describe in detail the organizational structure and staff background in the school. A sixth variable, Demographic Background, was also included as a description for each school.

Interorganizational Relations (IOR). This variable is a measure of school affiliations and staff activities which involve persons and organizations outside of the school. Subscores were developed for (a) school interactions with parents, (b) district support of the curriculum program, and (c) district-wide meetings about program issues and, for IGE schools only, membership in a regional group of IGE schools. Teacher scores were summed and averaged for a school score ranging from 0-6 points. Data on district support of the school's mathematics or reading curriculum program were obtained from the principal's questionnaire with a maximum of 3 points possible. All principals reported the frequency of district-wide meetings focused on curricular issues; points were allocated differently for IGE and non-IGE schools, although each group could receive a possible total of 3 points. An IOR total score is a sum of the three subscores and has a possible range of from 0 to 12 points (Nerenz, Webb, & Stewart, 1980).

Procedures Fostering Coordination and Improvement of the School Program (GOS). This variable is a measure of the school-wide procedures and practices which are designed to promote continuity and refinement of the overall school program. Scores for (a) release time for staff planning, (b) orientation programs for new teachers, and (c) inservice procedures were developed. A GOS total scale was derived by summing the points for these three elements (Nerenz, Webb, & Stewart, 1980).

Intraorganizational Structure (IOS). This variable is a measure of the school's internal organization and the mechanics of its functioning. Scores indicate the extent to which students and staff are organized into multiaged instructional units and the amount of time is available for regular meetings of the school's governing body. Unit leaders indicated how their school organization was best described: multigrade units, self-contained classrooms with some team teaching and coordination within grade levels, or self-contained classrooms. Information was also provided by the principal on a chart of school organization. All points for reports of multigrade units were developed from that chart. On the organization chart, principals reported grade range of units or teams, number of pupils per unit, and number of units holding regular weekly planning meetings.

An IOS total score is the sum of the school governance and school organization subscoring yielding a school-wide IOS score of up to 29 points (Nerenz, Webb & Stewart, 1980).

General Implementation of the Instructional Programming Model (IPM). This IPM is a measure of the extent to which the school is organized around the following steps of the IGE model for Instructional Programming for the Individual Student:

1. setting school-wide instructional objectives
2. selecting a subset of objectives for children in each unit
3. keeping and using records of assessment results
4. planning for instruction, including short-term grouping procedures
5. providing instruction, including variety in materials and in group size
6. assessing mastery of individual objectives
7. planning and evaluating the overall instructional program

Scores were developed by summing seven subscores, one for each of the seven steps, yielding a maximum of 120 points (Nerenz, Webb, & Stewart, 1980).

Teacher Experience (TE). This variable is a measure of staff teachers' overall experience in education as well as their experience in IGE schools. Scale values were assumed for each teacher. Results were then averaged yielding a school score ranging from 1 to 5 points (Nerenz, Webb, & Stewart, 1980).

Demographic Background (DB). This variable provides a description of the student population of the school. This scale was derived from the National Assessment of Educational Progress (NAEP) which used seven categories of size and type of community in reporting results. These seven categories (see sampling section earlier) were used to assess DB in Phase I of the IGE study and in Phase IV (Nerenz, Webb, & Stewart, 1980).

The Analysis Plan

In light of the research questions posed at the start of this chapter and of the operational problems faced in doing the study, a five-step analysis plan was followed:

Step 1--School Descriptions. Differences in the operating characteristics among the three types of schools (IGE DMP, non-IGE DMP, and IGE-non-DMP) were anticipated to predict differences in the way instructional time was used and in turn predict student performance on specific mathematics objectives. At this initial step, the schools were to be described in terms of the school background and program use variables in order to demonstrate that the labeled differences (IGE or not, DMP or not) were reflected in operational differences. This analysis is presented in Chapter III.

Step 2--Time Use Difference. The difference in how time was allocated and used in each school at each of the two grade levels

(Grades 2 and 5) was then summarized. The analysis for Grade 2 is presented in Chapter IV and for Grade 5 in Chapter V.

Step 3--Student Achievement Differences. The presentation of differences in student achievement on each of the content variables for each of the schools was the next step. In Chapter VI mathematics performance for both Grade 2 and Grade 5 is presented.

Step 4--Predictive Analysis for Engaged Time. It was planned that student on task behavior (as measured by engaged time) for each content objective and area in this step would be used as a dependent variable for each grade level. However, this regression analyses was not carried out. The final number of participating schools made this analysis unfeasible.

A second set of regression analyses was planned and performed. Here student performance on content objectives for each grade was used as the dependent variable and the student pursuits variables added to the set of predictor variables. A summary of this analysis appears in Chapter VII.

III

Schools and How They Group

The study design specified that triads of schools would comprise the sample. Within each triad, schools were to represent the same demographic setting, differing on use of DMP and on adoption of IGE. Thus, within each triad, there was to be one IGE school setting using DMP, one IGE school using an alternative program, and one non-IGE school using DMP. After school opening in fall 1978, the medium city IGE school using DMP withdrew from the study. Remaining triads and the schools in each of these--listed in IGE/DMP, IGE/non-DMP, and non-IGE/DMP order--are as follows: extreme rural, Schools 440, 428, and 904 Grade 2/905 Grade 5; urban Schools 593, 333, and 762; and medium city, Schools 421, and 906. Differences in operating characteristics among the three types of schools, background variables, were anticipated to predict differences in the way in which instructional time was used; time use, in turn, was anticipated to predict student performance on objective-based assessments.

The schools are described by type in the following section. After the descriptions, scores on background and program use variables are presented and discussed.

SCHOOL DESCRIPTIONS

IGE/DMP

School 440 is located in a town of about 2,000 people and serves children from the town and its surrounding rural area. It is one of three elementary schools in the district and had been a DMP trial school since the program's developmental stages. The program was implemented in sequence, with the students who began with DMP in kindergarten continuing with the program during each successive year. The school has approximately 50 students in each grade, K-6. The four teachers who were interviewed each reported three to six years of teaching experience.

Within grade levels, two ability groups that remained relatively stable throughout the year were formed for math instruction. This stability is increased by the fact that the same six students were always grouped and observed together at each grade level for the entire observation period. With the exception of occasional student teachers, no one other than the teacher was involved in implementing DMP. DMP topics were generally covered in numerical sequence without deletions. While both Grade 2 teachers and one Grade 5 teacher used primarily DMP materials, including student guides, workbooks, manipulatives, and the resource manual, this teacher taught particular strands of DMP straight through rather than cycling through all strands. The other Grade 5 teacher supplemented the DMP program with a large number of worksheets. Observations were conducted of all teachers.

School 593 is located in a town on the outskirts of a large midwest metropolitan area. Local small industries employ the majority of workers in the town, so that its atmosphere is more that of a small to medium city than that of a suburban community. This prekindergarten-Grade 8 school has 45-50 students per grade and is the only school in the district.

Both teachers who were interviewed reported having seven or more years of teaching experience; since School 593 organized its first I&R Unit in fall 1971, it is possible that they and other teachers had participated in initial IGE implementation steps. They did not regroup children according to the Instructional Programming Model; the principal noted that student groups were based on a test administrated at the beginning of the year and observation showed the same six students were always together.

Second-grade classes were provided in an open area that also included pre-kindergarten, kindergarten, and first graders. Both classes participated in testing, and observations were conducted in one class that was occasionally taught by a student teacher. Fifth-grade staff and students were in self-contained classrooms separate from the rest of the school. However, students did move from one area to another for both math and reading instruction. As at Grade 2, both fifth grade classes were tested but observations were conducted in only one of the classes.

IGE/non-DMP

School 333 is in an area described as urban fringe, a suburb of a large midwest city. The building has two open areas, one for each of Grades 1-4 and 4-6; the kindergarten area is separate. There were approximately 60 students in each grade, and of the three teachers interviewed, two reported seven or more years experience and one, three to six years.

At Grade 2, math was taught for 30 minutes each morning. The two teachers sometimes worked together with the entire group of children, although each also taught separately. One text/workbook series was the basis for second-grade instruction and a large number of teacher-made materials were also used. The math program for the upper grades is based on sets of objectives defined for decimals, fractions, geometry, multiplication, and so on. At the beginning of the 50-minute instructional period, children first checked in with an aide to see which area they were to work in, then picked up the appropriate materials. Although each work area in the 4-6 unit was supervised by a teacher, this teacher rarely worked with the entire group. Rather, individuals worked on their own, getting help from the teacher as needed or having the teacher check their work. Once particular sets of objectives were completed, students moved to a self-contained testing room where they took the appropriate exam for their objective and then were immediately recycled into another learning area. Thus, even though the same six children were observed during the entire observation period, these six students were always working on different skills. The math program was truly "individualized" in the sense that each child progressed alone and was seldom associated with a larger group of children.

School 421 is located in a medium city with an economy based on small businesses and farming and with a medium-sized university. The school is K-6, has been an IGE school since 1969, and has approximately 60 students in each grade. The relatively modern school building has a central IMC and self-contained classrooms, as well as more open instructional areas around the perimeter. During the 1978-79 school year, the two fifth grades were located in self-contained rooms; however, the fifth-grade teacher decided not to participate in the study after the first few days so no data were collected on these children.

The 58 second graders were part of the second "community" or unit within the school and were grouped with first and third graders. They occupied two adjacent open instructional areas. Varied groupings and materials were used during instruction at Grade 2, and as evidenced some regrouping did occur during the observation period. Sixteen observations were conducted during the study period. Target students were selected from a group of 28 students reported by the principal to be average or below average. The two second-grade teachers who were interviewed each reported two to six years of experience.

School 428 is a K-4 school in a K-12 district located in a very small rural community. Many of the town's adult residents commute to larger towns 10-20 miles away or work on nearby farms or in the town's one small industry. There is concern about the declining elementary enrollment. The school has used IGE since 1971; math and reading instruction follows an IGE model, and social studies is expected to soon be reorganized following IGE procedures. Staff stability is high with both fifth-grade teachers reporting seven or more years experience and the second grade teacher three to six years.

In the K-2 unit, instruction was provided separately by grade. For mathematics, both second-grade ability groups were taught by one teacher for nine weeks while the other teacher instructed the four ability groups formed for reading. The two ability groups used for Grade 2 mathematics instruction ware based on results of testing at the beginning of Grade 1; few children were changed from group to group for math instruction during either Grade 1 or Grade 2. In the 5-8 unit, there are three potential fifth-grade teachers but only one was observed. As at Grade 2, instruction was generally provided in large groups followed by individual seatwork and, as shown by the observation records, students were not frequently regrouped by skill needs within a school year or even across years.

School 762 is in a large western metropolitan area in a neighborhood with a high proportion of adult residents on welfare or not regularly employed; this is considered a Title I school. About 65% of the students were Chicano with most others being black or of another minority group. The school was K-6 and had about 80 students in each grade. Both of the teachers who were interviewed reported three to six years of teaching experience.

This school was the only one using DMP in the school district and both teachers' and administrators' attitudes towards the program were very positive. Manipulatives and varied group sizes were used, with each child's daily program divided into three sections--an individually prepared seatwork assignment, a computation small group, and a DMP-topic small group directed by the teacher. DMP content was taught in strands four days each week, and new students were pre-tested to determine their skill needs. Tests and observational data were obtained in each of the Grade 2 classrooms; however, since the Grade 5 staff declined to participate in the study, no Grade 5 data were collected.

Schools 904 and 905 are elementary (Grades K-3) and intermediate (Grades 4-6) schools in a county school system drawing on a mixed socio-economic base near a larger southern metropolitan area; both were Title I schools with fewer than 20% of the students being black. Each school had about 625 children. Because a bond issue had failed, classes were quite large and it was not anticipated that money would be made available for needed expansion of the schools in the near future. The second-grade teacher reported having seven or more years experience; the fifth-grade teacher had taught only one full year prior to the study.

The district had approved DMP and teachers could decide which program they wanted to use. Within a program, however, teachers were issued materials for their grade only and thus were quite conscious of the distinction between a Grade 4 DMP topic, for instance, and a Grade 5 DMP topic. Although students were regrouped by skill needs for reading instruction, they were not regrouped or cross-age grouped for math. Manipulatives were used, especially at Grade 2, in which DMP was the primary program. At Grade 5 DMP was used as a supplementary program. One class was tested and observed at each grade.

School 906 is one of nine K-5 elementary schools in a medium city that has both a large state university and an automobile plant. It serves about 350 children. The school's neighborhood has modest homes with about 20% of the children of non-white heritage. The district textbook committee had approved two mathematics curriculum programs, leaving purchase decisions to be made by school staffs. At School 906, DMP had been used alone for three years. At Grade 2, tests and observations were conducted in one self-contained classroom of about 25 students. The two fifth-grade teachers team taught in a larger area with about 50 students.

Although students in this group were regrouped by skill level across subject areas, they were not regrouped within a subject area; the math groups developed at the beginning of the year were not substantially altered during the observation period. The same six children were always observed at both Grade 2 and Grade 5. Since the staff at this school did not participate in structured interviews, background variable scores could not be developed.

SCHOOL SCORES

Background variable scores are shown in Table 3 for each school separately; averages for the three school types and the total sample are also provided. The first four variables (IOR, IOS, GOS, and IPM) represent IGE characteristics; the next two (TEXP and DB) were included for descriptive purposes; the last two represent program use.

IGE/DMP

Background variable scores for School 440 were midrange relative both to other schools in the study and to possible score values. The IOR score was 6.25/12; GOS, 14.75/24; IOS, 17/29; and IPM 52.75/120. For DMP implementation School 440 received 9 of 10 points; for program customizing, the school received a quite different .5 of 6 points.

On three of the four background variables, School 593 scored high both relative to the maximum possible score and relative to other schools in the study. The GOS score was 18/24; IOS, 26/29; and IOR, 9/12. For use of the IPM, in contrast, the score was 34/120, second lowest in the study. A similar contrast emerged in the program use scores; for extent of DMP implementation School 593 received the maximum 10 points; for program customizing, School 593 received 1 of 6 possible points, the second lowest score in

Table 3

Math Schools Background and Program Use Variable Scores for Label Groups

School	IOR (12)[a]	IOS (29)	GOS (24)	IPM (120)	TEXP (5)	Scaled DB	IMPL (10)	CUST (6)
IGE/DMP								
440	6.25	17.00	14.75	52.75	4.00	2	9.00	.50
593	9.00	26.00	18.00	39.00	5.00	6	10.00	1.00
Mean	7.62	21.50	16.38	45.88	4.50	4	9.50	.75
Sd(n)	1.38	4.50	1.63	6.88	.50	2.00	.50	.25
IGE/non-DMP								
333	8.25	27.00	13.25	58.00	4.66	6	0	1.00
421	10.50	26.00	6.50	80.00	4.00	5	0	3.50
428	7.50	14.00	17.75	71.75	4.66	2	0	3.50
Mean	8.75	22.33	12.50	69.92	4.44	4.33	0	1.83
Sd(n)	1.27	5.91	4.62	9.07	.31	1.70	0	1.18
non-IGE/DMP								
762	6.00	15.00	15.00	77.00	4.00	1	10.00	1.00
904	1.00	0.00	10.00	46.00	4.00	2	9.00	1.00
905	3.00	5.00	15.00	17.00	1.00	2	4.00	1.00
906	no questionnaires							
Mean	3.33	6.67	13.33	46.67	3.00	1.67	7.67	1.00
Sd(n)	2.05	6.24	2.36	24.50	1.41	.47	2.62	0
Grand Mean	6.44	16.25	13.78	55.19	3.92	3.25	5.25	1.25
Sd(n)	2.94	9.38	3.62	19.95	1.16	1.92	4.44	.87

[a] Maximum possible score is given in parentheses.

the study. Thus, School 539 seems to have the overt structural characteristics of an IGE school but to provide instruction in a rigid mechanical manner.

IGE/non-DMP

Background variable scores for School 333 was quite good for IOS (27/29) and IOR (8.25/25/12), and moderate for GOS (13.25/24) and IPM (58/120). These scores ranked first, third, fourth, and fourth in the study. On program customization, School 333, like five others, scored 1 of 6 points.

School 421's GOS score was 6.50/24, lowest in the DMP study. Scores on the other three background variables were quite different: the IOS score of 26/29 was second highest; both the IOR score (10.5/12) and the IPM score (80/120) were highest in the study. For program customization, School 421 scored like six of the eight schools, 1 of 6 possible points.

Background variable scores for School 428 were midrange for IOR (7.5/12), GOS (10.75/24), and IOS (14/29); the IPM score was relatively higher (71.75/120), and relatively closer to the highest score in the study. For program customization, School 428 had a score of 3.5 out of 6 possible points, the highest in the DMP study.

Non-IGE/DMP

Background variable scores for School 762 varied from midrange for IOR and IOS to high for GOS and IPM. On IOR the score was 6/12, sixth in the study, and on IOS, 15/29 or fifth. On GOS, the school's score was 15/18 and on IPM, 77/120; both of these scores were second highest. School 762 obtained the maximum 10 points for DMP implementation. For program customization, the schools' score was 1/6 like that of five others in the study.

On the three background variables that reflect school-wide and district-wide characteristics, Schools 904 (grade 2) and 905 (grade 5) had similar scores with School 905 higher than 904. The schools differed more and 904 had higher scores than 905 on two instructional variables, use of the IPM and extent of DMP implementation. Both Schools 904 and 905, as well as four others in the study, had low scores on program customizing.

DISCUSSION

For both GOS and IPM, the non-IGE schools averaged slightly above one of the groups of IGE schools and had ranges that overlapped those of both groups of IGE schools. The overlap also occurred with one group of IGE schools on IOS and nearly occurred on IOR, although the non-IGE schools averaged much lower than IGE schools on these variables. Thus for these IGE-related scores, the label IGE school was not useful in grouping schools.[1] Rather than reject the idea that in schools with similar operating characteristics instructional time was used in similar ways and student performance outcomes were similar, we submitted the background variable scores to a cluster analysis.

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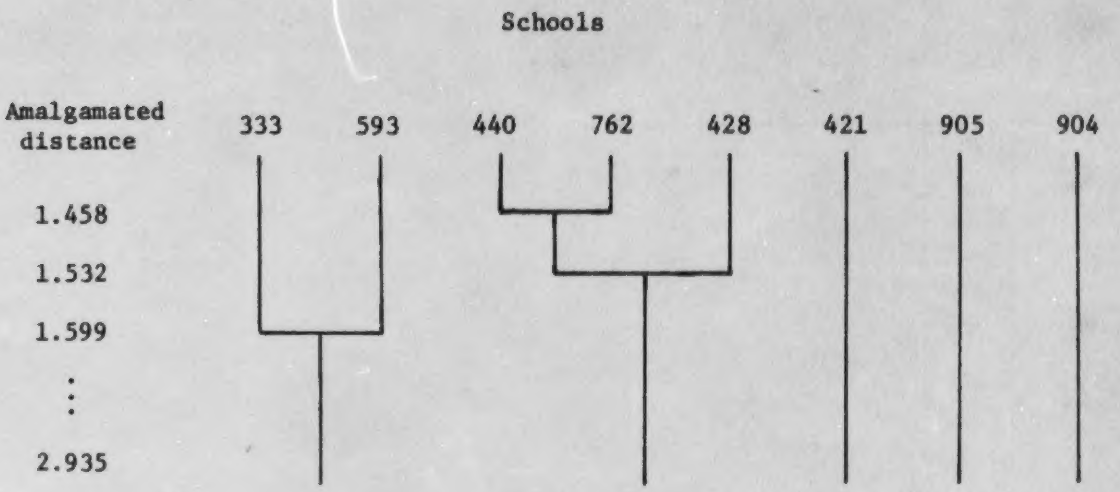
[1] IGE was not developed or disseminated as a simple new idea. Rather IGE is a synthesis of many existing ideas which, implemented together, represent a comprehensive alternative to traditional schooling. (For additional information, see Klausmeier, 1977.) It is not surprising, then, that schools not self-labeled IGE have characteristics that one would expect in an IGE school.

CLUSTER ANALYSIS

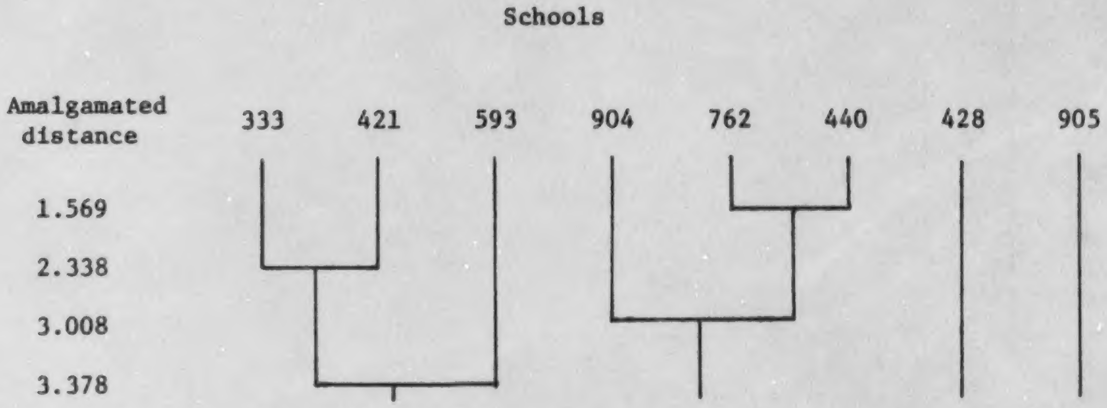
This analysis groups cases, in this instance schools, into pairs, triplets, and so on. The basis for grouping is the scores on the variables. Grouping continues until all cases are combined; at each step, the school added to a cluster is the one with variable scores least different from the variable scores of the existing cluster. The particular program used was P2M, cluster analysis of cases (April 1977 revision), from the Biomedical Computer Program series developed at the Health Sciences Computing Facility, UCLA. Euclidean distance was the measure used; all variable scores were standardized.

Two cluster analyses were carried out. The first used only background variables (IOR, IOS, GOS, IPM, TEXP, and scaled DB). For the second analysis, the two program use variables were added. Results of both analyses are shown in Figure 5. Schools 440 and 762 clustered in both analyses with an amalgamated (combined) distance of approximately 1.5. In the analysis with background variables only, school 428 was added to that cluster with a slight addition to combined distance and schools 333 and 593 clustered with a combined distance of 1.555; no other combinations with a distance less than 2.0 were formed. In the analysis using both background and program use variables, different clusters were formed with much greater distances.

Because the study design included prediction from background variables, the results of the first analysis were used to specify one cluster of three schools, one pair of schools, and three outliers. Averages for the clusters are shown in Table 4; scores for the schools are repeated from Table 3 to permit study of the results.


Schools
Amalgamated distance
333
593
440
762
428
421
905
904
1.458
1.532
1.599
2.935

Background variables


Schools
Amalgamated distance
333
421
593
904
762
440
428
905
1.569
2.338
3.008
3.378

Background and program use variables

Figure 5. Cluster groups and distances.

Table 4

Mathematics Schools Background and Program Use Variable Scores for Cluster Groups

School	IOR (12)[a]	IOS (29)	GOS (24)	IPM (120)	TEXP (5)	Scaled DB	IMPL (10)	CUST (6)
IGE/DMP								
428	7.50	14.00	17.75	71.75	4.66	2	0	3.50
440	6.25	17.00	14.75	52.75	4.00	2	9.00	.50
762[a]	6.00	15.00	15.00	77.00	4.00	1	10.00	1.00
Mean	6.58	15.33	15.83	67.17	4.22	1.67	6.33	1.67
Sd(n)	.66	1.25	1.36	10.42	.31	.47	4.50	1.31
IGE/non-DMP								
333	8.25	27.00	13.25	58.00	4.66	6	0	1.00
593	9.00	26.00	18.00	39.00	5.00	6	10.00	1.00
Mean	8.63	26.50	15.63	48.50	4.83	6	5.00	1.00
Sd(n)	.38	.50	2.38	9.50	.17	0	5.00	0
421[b]	10.50	26.00	6.50	80.00	4.00	5	0	1.00
904[b]	1.00	0	10.00	46.00	4.00	2	9.00	1.00
905[c]	5.00	5.00	15.00	17.00	1.00	2	4.00	1.00
Grand Mean	6.44	16.25	13.78	55.19	3.92	3.25	5.25	1.25
Sd(n)	2.94	9.38	3.62	19.95	1.16	1.92	4.44	.87

[a] Maximum possible score is given in parentheses.

[b] Only Grade 2 participated.

[c] Only Grade 5 participated.

The three schools in the cluster average low on IOR, IOS, and DB relative to the pair of schools and high on IPM. The two groups are not differentiated on GOS scores. Average scores on IPM are quite different for the two groups, although there is some overlap. School 421 resembles the pair of schools on IOR, IOS, and DB but has a GOS score much lower than any other school in the study and has the highest IPM score. Schools 904 and 905 are the elementary and intermediate schools in one rural district; scores from School 904 will enter into the Grade 2 analysis and scores from School 905, the Grade 5 analysis. These two schools are much lower than all others on IOR and IOS and lower than most on GOS: School 904 is fairly low on IPM, while School 905 is by far the lowest in the study.

In considering the utility of these school groups, it is useful to review what the variable scores measure. DB is purely descriptive. IOS is a measure of the paper organization of the school rather than the actual operation; for example, IOS scores reflect, in part, whether staff and students are organized in multigraded units rather than whether instruction is provided to multigraded groups of students. Three school features are represented in the IOR scores: parent visitation/participation, district support for the school's reading program, and regularly scheduled meetings with representation of other schools.

IPM scores are a sum of seven scores, each representing the school's implementation of one step of the IPM, as follows: 1 setting schoolwide instructional objectives, 2 selecting a subset of those objectives for students in teacher's instructional units, 3 assessing to determine students' instructional needs, 4 planning instructional programs based on those needs, 5 providing instruction with variations reflecting both instructional needs and learning styles, 6 reassessing to determine effects of instruction, and 7 feedback and recycling to the next instructional objective. Variations in IPM total scores resulted from differences in various subscores within and across groups.

Scores on the GOS, which primarily distinguished outliers from schools in groups, reflect the quality of new teacher orientation (in schools that have appreciable teacher turnover), the extent of inservice opportunities, and, with half the weight of the previous two features, the amount of release time for instructional planning.

Thus, the difference between two groups in IOR scores appears to be the only important consistent difference. It is insufficient to justify analysis by cluster. Therefore, analysis based on background and program use variables will include seven different schools at Grade 2 and five schools at Grade 5.

CONCLUSIONS

Examination of the background and variable scores indicates that the original hypothesis, that differences in background variables among types of schools would be useful in predicting time use, means of instruction, and pupil performance, is not sensible to test. The labels IGE school and DMP user to classify schools, but by intent rather than by actual operation.

IV

Time Use in Grade 2

Time allocated to mathematics instruction, the amount of time teachers intended to spend on various mathematics topics, is a gross measure of opportunity to learn. The number of hours allocated overall indicates the relative importance of mathematics in the elementary curriculum at various schools. Broken down by objective, allocated time informs us about the focus of instruction at various schools. However, not all of the time allocated to a particular curriculum area is active learning time for the students. A portion of the time, usually quite small, is not applied to the planned topic; during this time, students might be making the transition from the previous subject, participating in classroom management activities, or working on other content. During the remaining time, that available for instruction in the content area, all students are not always engaged in the instructional activities; some may be passing out papers, waiting for assistance, or simply not paying attention.

In this chapter, time is first discussed as it was allocated to the general objectives. Next observed time is discussed as a proportion of log allocated time. Available and engaged time are then discussed as proportions of observed allocated time. Finally data are presented about variables representing the instructional process:

use of three grouping patterns, use of three different types of materials, and the relative amount and origin of talk in the classroom.

Summary tables in this chapter are derived from data given by Nerenz and Webb (1980b) and Webb and Nerenz (1980a). The tables are arranged by label group (IGE/DMP, IGE/non-DMP, non-IGE/DMP) with cluster group indicated by T for the triplet of schools, P for the pair of schools, and -- (dash) for the three outliers.

Allocated Time

The total hours of mathematics instruction per child and the assignment of those hours to the 11 general objectives are given in Table 5. Overall, hours allocated during the 25-week study ranged from just over 40 at School 333 to over 90 at Schools 593 and 906. Clearly, addition and subtraction of whole numbers (04) is the heart of the second-grade mathematics program, regardless of curriculum program used. At the DMP schools, writing numbers (01) and word problems (12) both had a substantial proportion of time allocated. At the non-IGE/DMP schools, over 10% of the time was allocated to fractions (07). At the various schools, different general objectives had been identified for additional emphasis: geometry (14) at Schools 440 and 762; miscellaneous topics (15) at Schools 593, 428, 421, and 333; and other place value (03) also at School 421. At School 906, time was allocated to only seven of the eleven general objectives; at other schools, time was allocated to nine or more of the objectives.

Table 5

Grade 2 Average Allocated Hours of Math Skills Instruction per Child

Over the Total Study Period

SCHOOL	CLUSTER	General Objective: Writing Numbers 01		Inequalities 02		Other place value or numeration 03		Addition and Subtraction 04		Multiplication 05		Fractions 07		Measurement 11		Word Problems 12		Applications 13		Geometry 14		Miscellaneous 15		TOTAL HOURS
		Hours	%	Hours	%	Hours	%	Hours	%	Hours	%	Hours	%	Hours	%	Hours	%	Hours	%	Hours	%	Hours	%	
IGE/DMP																								
440	T	18.7	31	1.8	5	.5	1	12.2	20	--	--	.7	1	3.1	5	15.0	25	.2	0^+	6.2	10	2.8	5	60.9
503	P	14.2	15	1.0	1	1.8	2	39.0	42	--	--	1.6	2	5.2	6	16.5	18	2.2	2	--	--	12.2	13	93.7
Mean		16.5	21	1.4	2	1.2	1	25.6	33	--	--	1.2	1	4.2	5	15.8	20	1.2	2	3.1	4	7.5	10	77.3
IGE/non-DMP																								
428	T	3.2	7	3.9	8	1.5	3	22.2	47	1.4	3	.5	1	2.3	5	1.2	3	--	--	1.6	3	9.1	19	46.9
421	-	.3	1	.0	0^+	9.3	17	24.7	45	.5	1	3.8	7	3.1	6	.7	1	.9	2	1.9	3	9.4	17	54.6
333	P	.3	1	.2	0^+	1.8	4	26.5	64	2.3	6	2.3	6	1.7	4	--	--	--	--	2.4	6	3.7	9	41.2
Mean		1.3	3	1.4	3	4.2	9	24.5	51	1.4	3	2.2	5	2.4	5	.6	1	.3	1	2.0	4	7.4	16	47.6
non-IGE/DMP																								
904	-	4.8	10	3.3	7	--	--	21.8	44	--	--	5.4	11	.1	0^+	9.6	19	.8	2	2.1	4	1.7	3	49.6
906	-	10.2	11	5.3	6	--	--	26.4	29	--	--	9.7	11	--	--	34.5	38	3.6	4	2.0	2	--	--	91.7
762	T	5.6	9	1.7	3	.4	1	21.6	36	2.5	4	8.3	14	--	--	9.9	17	6.6	11	6.6	11	3.2	5	59.8
Mean		6.9	10	3.4	5	.1	0^+	23.3	35	.8	1	7.8	12	.0	0^+	18.0	27	3.7	5	3.6	5	1.6	2	67.0
Triplet Mean		9.2	16	2.5	4	.8	1	18.7	33	1.3	2	3.2	6	1.8	3	8.7	16	2.3	4	4.8	9	5.0	9	55.9
Pair Mean		7.3	11	1.0	1	1.8	3	32.8	49	1.2	2	2.0	3	3.5	5	8.3	12	1.1	2	1.2	2	8.0	12	67.5
Grand Mean		7.2	12	2.2	3	1.9	3	24.3	39	.8	1	4.0	6	1.9	3	10.9	18	1.8	3	2.9	5	5.3	8	62.3

NOTE: No allocated time is indicated by --; less than .05 hours is indicated by .0. 0^+ indicates less than 0.5%.

In developing this table, it was necessary to assume that time for each objective was allocated equally to all children for whom logs were maintained; that is, if 18 hours were allocated during one period to addition and subtraction (04), that time would have been recorded as 3 hours per child where logs were maintained for 6 children, 2-1/4 hours per child where logs were maintained for 8 children, and so on.

IGE/DMP. Each of these schools allocated over three-quarters of the mathematics instructional time to three basic objectives: writing numbers (01), addition and subtraction of whole numbers (04), and word problems (12).

On the average, each second grader at School 440 was scheduled for 2.2 hours of mathematics instruction each week. During the study, nearly one-third of the time was allocated to instruction in writing numbers in expanded notation, one-quarter to word problems, and one-fifth to addition and subtraction of whole numbers. Thus, three-quarters of the year's mathematics skill instruction was devoted to these three basic objectives and an additional 10% to geometry. The time devoted to addition and subtraction of whole numbers was distinctly less, both in hours and in percent of time, at School 440 than at any other school.

At School 539, 3.4 hours per week of mathematics skill instruction were scheduled, on the average, for each child. At this school, as at School 440, three-quarters of the allocated instructional time was scheduled for instruction in the three basic objectives but with a different emphasis: 42% for addition and subtraction of whole numbers, 18% for word problems, 15% for writing numbers. An additional 13% of the instructional time was allocated to miscellaneous topics such as time, money, and graphs.

Non-IGE/DMP. At two of these three schools, as at the two IGE/DMP schools, about three-quarters of the time was allocated to the three basic objectives; at the third, nearly two-thirds. At least 11% of the time at each of these three schools was allocated to measurement of length and capacity, much more time than at other schools.

At School 904, on the average, each child was scheduled for 1.8 hours of mathematics instruction each week. Time was distributed across the basic objectives in the following manner: 44% to addition and subtraction, 19% to word problems, and 10% to writing numbers. Measurement was scheduled for 11%.

At School 906, 3.3 hours of mathematics instruction was scheduled, on the average, for each child each week. Word problems were allocated 38%; addition and subtraction, 29%; writing numbers, 11%. An additional 11% was allocated to measurement.

Second graders at School 762 were scheduled for an average of 2.1 hours of mathematics instruction each week. Of this time, 36% was allocated to addition and subtraction, 17% to word problems, and 9% to writing numbers. Measurement was scheduled for 14% of the time at this school and geometry for 11%.

IGE/non-DMP. At these three schools, addition and subtraction was the only basic objective to be scheduled for a large proportion of time and the proportion was larger than in the other two types of schools. The miscellaneous topics such as time, money, and graphs were allocated fairly large proportions of time at two schools, one of which also allocated considerable time to place value and numeration. At the third school in this group, the relatively little time not allocated to addition and subtraction was spread among four other objectives including the miscellaneous topics.

At School 333, an average of 1.5 hours per week was allocated to mathematics instruction. The strong emphasis on addition and subtraction is evidenced by its allocation of 64% of the instructional time. Four other objectives were allocated between 5% and 10% of the time: miscellaneous topics, 9%; multiplication, fractions, and geometry, 6% each.

At School 421, an average of 2 hours was scheduled for mathematics instruction each week. Addition and subtraction was allocated 45% of the time; miscellaneous topics and place value, 17% each. Fractions were allocated 7% and measurement, 6%.

At School 428, on the average children were scheduled for 1.7 hours of mathematics instruction each week. Addition and subtraction was allocated 47% of the total time; miscellaneous topics, 19%. At least 5% of the time was allocated to each three additional objectives at this school: 5% to measurement, 7% to writing numbers, and 8% to inequalities.

Proportion Observed

The relationship of observed time to log allocated time is shown in Table 6. As was stated earlier, 18 or more formal observations were made in each second grade during the 25-week study. Since testing occurred in six weeks during the period that teachers maintained logs of allocated time for the target students, observations were made in most of the remaining 19 weeks.

Table 6

Relationship of Allocated Time and Observed Time by Objective

SCHOOL	CLUSTER	Observations			General Objectives										
		No.	Total Hours	% of Allocated Time	Writing Numbers 01	Inequalities 02	Other place value or numeration 03	Addition and Subtraction 04	Multiplication 05	Fractions 07	Measurement 11	Word Problems 12	Applications 13	Geometry 14	Miscellaneous 15
IGE/DMP															
440	T	20	57.77	13	31,30	5,1	1,2	20,30	--,--	1,2	5,8	25,15	0^+,1	10,11	5,--
593	P	29	94.66	13	15,13	1,1	2,0	42,69	--,--	2,6	6,--	18,11	2,--	--,--	13,0^+
IGE/non-DMP															
428	T	18	37.94	15	7,--	8,12	3,7	47,45	3,--	1,0	5,--	3,--	--,--	3,11	19,26
421	-	18	47.48	12	1,1	0^+,--	17,9	45,47	1,--	7,7	6,--	1,--	2,--	3,3	17,34
333	P	20	59.50	21	1,--	0^+,--	4,5	64,63	6,5	6,5	4,--	--,--	--,--	6,4	9,17
non-IGE/DMP															
904	-	21	66.27	24	10,10	7,6	--,--	44,35	--,--	11,12	0^+,--	19,20	2,4	4,6	3,6
906	-	20	79.74	15	11,10	6,--	--,--	29,26	--,--	11,--	--,--	38,40	4,3	2,0^+	--,--
762	T	31	96.18	22	9,5	3,--	1,7	36,49	4,1	14,4	--,3	17,13	11,--	11,6	5,13

NOTE: For each general objective, the proportion of allocated time is given first, followed by the proportion of observed time.

Overall, from 12% to 24% of the log allocated time was observed. In most cases, the relative emphasis on general objectives that was shown in the logs was maintained in the observations; for example, for Objective 01, little or no instructional time was observed in these schools in which a small percentage of time had been allocated, and approximately the same percentage of time was logged and observed where 10% or more of the instructional time was allocated to Objective 01.

Nonapplied Time, Available Time, and Engaged Time

Formal observations were made during the time period in which mathematics instruction was scheduled in each school. Data on time use were developed from these observations. Briefly, the time use variables are as follows: nonapplied time, the portion scheduled for but not devoted to mathematics instruction; available time, the difference between scheduled observed time and nonapplied time; engaged time, the portion of available time that students were observed to be attending to instructional activities. (These variables are described in more detail in Chapter II.)

As shown in Table 7, the percentage of nonapplied time, and of course available time, varied among schools with the primary source of variation being School 762. Although the pair of Schools 333 and 593 seem well matched, Schools 904 and 906, outliers in the cluster analysis, are similar to them. Schools 428, an outlier, and 440, one in the triplet, are alike in nonapplied and available time.

Table 7

Nonapplied Time, Available Time, and Engaged Time as a Percentage of Observed Allocated Time, Grade 2

SCHOOL	CLUSTER	Nonapplied Time	Available Time		Engaged Time	
		Total Study	Total Study	Range for Periods A-G	Total Study	Range for Periods A-G
IGE/DMP						
440	T	10	91	86-95	60	54-66
593	P	4	96	94-99	69	63-77
Mean		7	93		64	
IGE/non-DMP						
428	T	7	93	88-100	75	60-84
421	-	14	86	74-91	46	34-69
333	P	6	94	91-99	70	49-80
Mean		9	91		64	
non-IGE/DMP						
904	-	5	95	84-100	72	63-80
906	-	4	96	93-99	66	58-73
762	T	39	61	46-85	40	34-59
Mean		16	84		59	
Triplet Mean		19	82		70	
Pair Mean		5	95		55	
Grand Mean		11	89		62	

At both Schools 762 and 421, students were engaged in instructional activities during less than half of the observed allocated time. At all other schools except School 400, students were engaged during two-thirds to three-fourths of the observed allocated time. The pair of Schools 593 and 333 had very similar engagement rates, 69% and 70% respectively, with the other three schools differing by a few percentage points. Again, analysis seems appropriately conducted on individual schools, rather than on label or cluster groups.

The allocated instructional hours for each child from Table 5 and the overall percentage of engaged time from Table 7 together provide estimates of the time allocated to mathematics instruction each week and the average engaged time for each child (Table 8).

At Schools 593 and 906 nearly 4 hours were allocated to mathematics instruction each week, about 45 minutes a day. This allocation is highest in the study, half again as much as at schools with the next highest allocation. Because the engaged rate was fairly high at these schools, the estimated hours per week of engaged time is also highest in the study, about two and one-half hours a week.

At Schools 440, 428, and 904, about one and one-half hours a week are estimated for engaged time. Allocated hours were higher at School 440 but the engagement rate at that school was low enough that estimated engaged time for that school was the same as that for schools with 20% less allocated time.

Table 8

Estimated Hours Allocated and Engaged for Each Child Each Week, Grade 2

SCHOOL	CLUSTER	Hours Allocated per Child Total Study[a]	 Per Week	Engaged Time %[b]	 Estimated Hours/Week
IGE/DMP					
440	T	60.9	2.4	60	1.5
593	P	93.7	3.7	69	2.6
Mean		77.3	3.1	65	2.1
IGE/non-DMP					
428	T	46.9	1.9	75	1.4
421	-	54.6	2.2	46	1.0
333	P	41.2	1.6	70	1.2
Mean		47.6	1.9	64	1.2
non-IGE/DMP					
904	-	49.6	2.0	72	1.4
906	-	91.7	3.7	66	2.4
762	T	59.8	2.4	40	1.0
Mean	T	67.0	2.7	59	1.6
Triplet Mean		55.9	2.2	58	1.3
Pair Mean		67.5	2.7	70	1.9
Grand Mean		62.3	2.5	62	1.6

[a] From Table 5.

[b] From Table 7.

About an hour a week was the estimated engaged time at Schools 421, 333, and 762. The effects of engagement rate are even more dramatic for this group of schools, with the least time allocated to mathematics instruction at School 333 and the most time estimated engaged each week.

Means of Instruction

Use of the three group sizes and three primary types of materials and incidence of teacher and student interactions are summarized in Table 9. For none of these instructional variables did a consistent pattern emerge for label groups or for cluster groups. Average differences due to one or two extreme scores and overlapping ranges are typical of the label groups. For example, although the averages show that individual work was observed for a smaller proportion of time at the DMP schools, the range of the DMP schools overlaps the range of the non-DMP schools; the two very low proportions are from DMP Schools 440 and 904 while the one very high proportion is from non-DMP School 333. Similarly, from the means for the triplet and of schools, the cluster analysis appears to have identified two sets of schools that use large and small groups in distinctly different proportions; however, the proportions from outlier School 904 are more like those of Schools 428 and 762 than are the proportions for triplet member school 440. Thus, the discussion below of grouping patterns, use of materials, and classroom interactions is based on overall patterns.

Table 9

Instructional Process Variables as a Percentage of Available Time, Grade 2

		Group Sizes[a]			Materials[b]			Interactions[b]	
SCHOOL	CLUSTER	Individual	Small	Large	Paper Special	Manipulative	Print	Teacher	Student
IGE/DMP									
440	T	38	11	49	77	45	0	25	9
593	P	65	7	28	51	5	44	9	11
Mean		52	9	39	64	25	22	17	10
IGE/non-DMP									
428	T	61	2	37	90	9	1	12	8
421	-	69	20	12	76	12	0	9	8
333	P	82	4	15	85	0^+	45	9	10
Mean		71	9	21	84	7	15	13	9
non-IGE/DMP									
904	-	57	4	38	87	8	31	12	5
906	-	34	22	44	82	76	11	19	12
762	T	56	6	38	80	23	7	13	6
Mean		49	11	40	83	36	16	15	8
Triplet Mean		52	6	41	82	26	3	17	8
Pair Mean		74	6	22	68	3	45	9	11
Ground Mean		58	10	33	79	22	17	14	9

[a] Percents may not sum to 100 due to rounding.

[b] Percents need not sum to 100.

Paper-and-pencil materials are used over three-fourths of the time in seven of the eight schools and over half of the time at the eighth, School 593. That school and School 333, paired in the cluster analysis, are similar in their low rate of use of manipulatives and high rate of use of printed materials; at School 904 materials were similarly used.

At Schools 440, 428, and 421 printed materials were rarely used. At School 440, manipulatives were in use nearly half of the time but only about 10% of the time at the other two schools.

Variability was greater in proportion of teacher interactions than in proportion of student interaction. In addition, there was generally a larger proportion of teacher interactions than student interactions. At the two exceptions to the latter observation, Schools 593 and 333, there was little difference in the percentages; a very small difference in the two proportions also occurred at School 421.

Interactions were observed about 20% of the time in most schools. At Schools 440 and 906, interactions were observed about one-third of the time.

V

Time Use in Grade 5

Time allocated to mathematics instruction, the amount of time teachers intended to spend on various mathematics topics, is a gross measure of opportunity to learn. The number of hours allocated overall indicates the relative importance of mathematics in the elementary curriculum at various schools. Broken down by objective, allocated time informs us about the focus of instruction at various schools. However, not all of the time allocated to a particular curriculum area is active learning time for the students. A portion of the allocated time is not applied to the planned topic; during this time, students might be making the transition from the previous subject, participating in classroom management activities, or working on other content. During the remaining time, that available for instruction in the content area, all students are not always engaged in the instructional activities; some may be passing out papers, waiting for assistance, or simply not paying attention.

In this chapter, time is first discussed as it was allocated to the general objectives--this data comes from teacher logs. Next, observed allocated time is discussed as a proportion of log allocated time. Available and engaged time are then discussed as proportions of observed allocated time. Finally data are presented about variables representing the instructional process: use of three grouping patterns, use of three different types of materials, and the relative amount and origin of talk in the classroom.

Summary tables in this chapter are derived in part from data given by Nerenz and Webb (1980b, 1980c) and Webb and Nerenz (1980a). The tables are arranged by label group (IGE/DMP, IGE/non-DMP, and non-IGE/DMP) with cluster group indicated by T for the two schools originally in the triplet, P for the pair of schools, and -- for the two others.

Allocated Time

The estimated total hours of mathematics instruction for each child and the assignment of those hours to the general objectives are given in Table 10. In developing this table it was necessary to assume that time for each objective was allocated equally to all children for whom logs were maintained; that is, if 18 hours were allocated during one period to Division (06), that time would have been recorded as 3 hours per child where logs were maintained for 6 children, 2-1/4 hours per child where logs were maintained for 8 children, and so on.

Overall hours allocated during the 25-week study ranged from nearly 70 at School 593 to over 90 at School 440. There was no general pattern of instruction differentiating the label groups, although the non-IGE/DMP schools were more similar than the other two groups. The cluster groups were similar in breadth of instruction: at Schools 440 and 428 from the triplet, some time was allocated to all 12 general objectives; at the pair of Schools 593 and 333 time was allocated to 7 and 8 general objectives, respectively. At School 906 time was allocated to all objectives, and at School 905, to 10 objectives.

Division (06) was the only general objective to which all schools allocated a substantial proportion of time. All schools except School 593 also allocated at least 10% of the time to Fractions Computes (08). At School 593, a third of the time was allocated to Decimals Computes (10),

Table 10

Grade 5 Average Allocated Hours of Mathematics Skills Instruction per Child Over the Total Study Period, by Objective

		General Objective													
		04		05		06		07		08		09		10	
SCHOOL	CLUSTER	Hours	%	Hours	%	Hours	%	Hours	%	Hours	%	Hours	%	Hours	%
IGE/DMP															
440	T	2.7	3	11.0	12	16.7	18	28.0	31	13.3	15	.3	0^+	.5	1
593	P	3.0	4	--	--	18.9	27	13.8	20	4.7	7	1.1	2	22.9	33
Mean		2.9		5.5		17.8		20.9		9.0		.7		11.7	
IGE/non-DMP															
428	T	.9	1	8.5	10	16.7	20	17.7	22	8.5	10	2.8	3	6.5	8
333	P	--	--	6.4	8	13.0	15	5.6	7	17.6	21	--	--	3.0	4
Mean		.5		7.5		14.9		11.7		13.1		1.4		4.8	
non-IGE/DMP															
905	-	.6	1	22.0	29	14.6	19	8.4	11	20.0	26	.3	0^+	2.3	3
906	-	1.3	2	18.0	21	20.1	24	12.9	15	14.5	17	4.5	5	1.5	2
Mean		1.0		20		17.4		10.7		17.3		2.4		1.9	
Triplet mean		1.8		9.8		16.7		22.9		10.9		1.6		3.5	
Pair mean		1.5		3.2		16.0		9.7		11.2		.6		13.0	
Grand mean		1.4		11.0		16.7		14.4		13.1		1.5		6.1	
Standard deviation		1.2		8.0		2.6		2.6		5.7		1.8		8.5	

NOTE: No allocated time is indicated by --; less than .05 hours is indicated by .0. 0^+ indicates less than 0.5%.

Table 10 (continued)

		General Objective										
SCHOOL	CLUSTER	11 Hours	%	12 Hours	%	13 Hours	%	14 Hours	%	15 Hours	%	TOTAL HOURS
IGE/DMP												
440	T	4.9	5	2.4	3	1.8	2	3.7	4	5.6	6	90.9
593	P	--	--	--	--	--	--	--	--	4.9	7	69.3
Mean		2.5		1.2		.9		1.9		5.3		80.1
IGE/non-DMP												
428	T	3.2	4	3.2	4	1.1	1	3.7	5	9.4	11	82.2
333	P	--	--	4.8	6	--	--	19.5	23	15.2	18	85.1
Mean		1.6		4.0		.6		11.6		12.3		83.7
non-IGE/DMP												
905	-	--	--	3.6	5	--	--	4.2	5	.9	1	76.9
906	-	6.7	8	1.6	2	1.0	1	1.5	2	1.6	2	85.2
Mean		3.4		2.6		.5		2.9		1.3		81.1
Triplet mean		4.1		2.8		1.5		3.7		7.5		86.6
Pair mean		--		2.4		--		9.8		10.1		77.2
Grand mean		2.5		2.6		.65		5.4		6.3		81.6
Standard deviation		2.9		1.7		.76		7.1		5.3		7.6

much more than at the other schools. Instruction at this school was focused on objectives 06, 07, and 10 to which 80% of the time was allocated. At three other schools, different objectives were emphasized in addition to 06 and 08: at School 440 nearly one-third of the time was allocated to Fractions Concept (07) with the result that nearly half of the time was allocated to fractions; at School 333 nearly one-fourth of the time was allocated to geometry and another 18% to miscellaneous topics; at School 905, Multiplication (05) was the additional general objective to which a large proportion of time was allocated, 29%. At Schools 428 and 906 the proportion of time allocated to objectives was never extremely large.

The very small proportion of time allocated to Word Problems (12) and Applications (13) is disappointing. These objectives comprise the aggregate objective Problem Solving which, for most adults, is the primary application for mathematics in school.

Proportion Observed

The relationship of log allocated time and observed time is shown in Table 11. From 16 to 21 formal observations were made in each fifth grade during the 25-week study, representing from 13% to 16% of the allocated time. In most cases, the instructional emphasis shown in the logs was maintained in the observations; that is, a large proportion of the observed instruction concerned those objectives to which a large proportion of time had been allocated.

Table 11

Relationship of Allocated Time and Observed Time by Objective

		Observations			General Objective											
SCHOOL	CLUSTER	No.	Total Hours	% of Alloc. Time	04	05	06	07	08	09	10	11	12	13	14	15
IGE/DMP																
440	T	20	108.80	15	3,4	12,10	18,23	31,28	15,14	0+,--	1,--	5,3	3,5	2,2	4,7	6,4
593	P	20	73.92	13	4,--	--,--	27,26	20,34	7,4	2,--	33,29	--,--	--,--	--,--	--,--	7,6
IGE/non-DMP																
428	T	17	79.23	16	1,1	10,6	20,34	22,24	10,4	3,5	8,3	4,--	4,--	1,--	5,--	11,12
333	P	16	65.09	13	--,--	8,12	15,16	7,2	21,18	--,2	4,4	--,--	6,5	--,--	23,25	18,16
non-IGE/DMP																
905	-	21	70.18	15	1,--	29,33	19,27	11,13	26,20	0+,--	3,4	--,--	5,--	--,--	5,3	1,--
906	-	20	99.00	15	2,0+	21,27	24,17	15,21	17,10	5,3	2,5	8,11	2,3	1,3	2,1	2,0+

NOTE: For each general objective, the proportion of allocated time is given first, followed by the proportion of observed available time.

Nonapplied Time, Available Time, and Engaged Time

Formal observations were made during the time period in which mathematics instruction was scheduled in each school. Data on time use were developed from these observations. Briefly, the time use variables are as follows: nonapplied time, the portion scheduled for but not devoted to mathematics instruction; available time, the difference between scheduled observed time and nonapplied time; engaged time, the portion of available time that students were observed to be attending to instructional activities. (These variables are described in more detail in Chapter II.)

As shown in Table 12, the percentage of nonapplied time, and of course available time, did not vary greatly among schools. The largest percentage of nonapplied time was observed at the two IGE/DMP schools which were similar to each other. The non-IGE/DMP schools also were similar. No other similarities in nonapplied time occurred--label groups or cluster groups. The smallest percentage was noted at School 333, which had a consistently large percentage of available time across instructional periods.

Variability among schools increased for engaged time. The label group of IGE/non-DMP schools were similar to one another and had a higher average engagement rate than the other label groups. The pair of Schools 593 and 333 were similar and had a high engagement rate. Schools 440 and 428 from the triplet had the lowest and highest engagement rates respectively. At School 593, the engagement rate was most consistent across instructional periods; it was sufficiently high that the second highest percentage of engaged time was observed there, even though the percentage of available time had been lowest.

Table 12

Nonapplied Time, Available Time, and Engaged Time as a Percentage of Observed Allocated Time, Grade 2

			Available Time		Engaged Time	
SCHOOL	CLUSTER	Nonapplied Time	Total Study	Range for Periods A-G	Total Study	Range for Periods A-G
IGE/DMP						
440	T	8	92	83-99	56	49-66
593	P	10	90	87-96	75	70-80
Mean		9	91		66	
IGE/non-DMP						
428	T	5	95	77-99	78	63-85
333	P	2	98	96-100	74	66-82
Mean		4	97		76	
non-IGE/DMP						
905	-	4	96	90-99	72	69-80
906	-	6	94	89-99	64	51-74
Mean		5	95		68	
Triplet mean		7	94		67	
Pair mean		6	94		75	
Grand mean		6	94		70	
Standard deviation		3	3		8	

NOTE: Available time and engaged time are shown separately for each instructional period in appendix Table M5LTU. Nonapplied time is broken down by type in appendix Table M5NAPT.

The allocated hours of instruction from Table 10 and the overall percentage of engaged time from Table 12 together permit estimation of the average weekly engaged time for each child (Table 13). There was less variability among schools in engaged time than in allocated time.

The IGE/DMP schools had the extremes in allocated hours and the lowest average engaged hours, only slightly below the non-IGE/DMP schools. The IGE/non-DMP schools were average in allocated time and superior to the DMP schools in engaged hours.

Means of Instruction

The IGE Instructional Programming Model provides for the use of a variety of group sizes and of instructional materials to meet children's individual instructional needs. Developing Mathematical Processes was developed consistent with the IGE philosophy; in addition DMP was based on the belief that children best learn and apply mathematical ideas by working with physical materials. Thus, all schools were expected to use a variety of group sizes and materials, with DMP schools using manipulatives to a greater extent than non-DMP schools. Student interactions should increase with increased use of small groups.

Use of the three group sizes and the three primary types of materials and incidence of teacher and student interactions are summarized in Table 14. In use of the three group sizes the two non-IGE/DMP schools are similar to each other and different from the other two label groups; only in use of small groups, however, is there no overlap in the range of individual school scores. The IGE/DMP schools had a much higher rate of teacher interactions than the other two groups. The pair, Schools 593

Table 13

Estimated Hours Allocated and Engaged for Each Child Each Week, Grade 5

		Hours allocated per child		Engaged time	
SCHOOL	CLUSTER	Total study[a]	Per week for 25 weeks	Percent[b]	Estimated hours/week
IGE/DMP					
440	T	90.9	3.6	56	2.0
593	P	69.3	2.8	75	2.1
Mean		80.1	3.2	66	2.1
IGE/non-DMP					
428	T	82.2	3.3	78	2.6
333	P	85.1	3.4	74	2.5
Mean		83.7	3.4	76	2.6
non-IGE/DMP					
905	-	76.9	3.1	72	2.2
906	-	85.2	3.4	64	2.2
Mean		81.1	3.3	68	2.2
Triplet mean		86.6	3.5	67	2.3
Pair mean		77.2	3.1	75	2.3
Grand mean		81.6	3.3	70	2.3
Standard deviation		7.6	.3	8	.2

[a] From Table 10.

[b] From Table 12.

Table 14

Instructional Process Variables as a Percentage of Available Time, Grade 5

SCHOOL	CLUSTER	Group Sizes[a]			Materials[b]			Interactions[b]	
		Individual	Small	Large	Paper & Pencil	Manipulatives	Print	Teacher	Student
IGE/DMP									
440	T	66	5	30	89	10	9	18	4
593	P	38	0	62	80	0	61	31	9
Mean		52	3	46	85	5	35	25	7
IGE/non-DMP									
428	T	51	3	46	90	4	50	14	11
333	P	99	1	0	98	0	25	1	7
Mean		75	2	23	94	2	38	8	9
non-IGE/DMP									
905	-	80	10	11	87	2	67	7	8
906	-	75	16	9	96	12	55	7	10
Mean		78	13	10	92	7	61	7	9
Triplet mean		59	4	38	90	7	30	16	8
Pair mean		69	1	31	89	0	43	16	8
Grand mean		68.17	5.83	26.33	90.00	4.67	44.50	13.00	8.17
Standard deviation		21.66	6.11	24.09	6.48	5.16	22.63	10.64	2.48

[a] Percents may not sum to 100 due to rounding.

[b] Percents need not sum to 100.

and 333 were alike in their nonuse of manipulatives. Overall, there is no pattern of instruction that can be attributed to labels or to the cluster groups.

As noted above, at both non-IGE/DMP schools small groups were observed more than at other schools. At Schools 440 and 906, both DMP schools, manipulatives were used more than at other schools. Even at these schools, small groups and manipulatives were used less than expected.

Individual work was dominant in all schools except School 593; at School 333 it was essentially the only instructional group. These two schools were also the extremes in use of large groups, with School 593 using large groups 62% of the time and School 333 never using large groups.

Paper and pencil materials were in use nearly constantly in all schools; manipulatives, as noted above, were used little if at all. In materials use school showed the greatest variability in use of print materials, ranging from less than 10% of the time at School 440 to nearly 70% at School 905.

At School 593, teacher interactions were observed nearly one-third of the time, more than the total interactions observed at any other school. School 333 was quietest, with interactions observed only 8% of the time. There was greater variability in the proportion of teacher interactions than student.

VI

Achievement Results

All general objectives and aggregate objectives were identified in Table 2. Those represented in the achievement monitoring tests are listed in Table 15 along with the number of items contributing to the score for each general objective and aggregate. Scores are reported as proportions of actual number of correct responses to possible number of correct responses. For aggregate objectives, scores are weighted averages of the scores for contributing objectives. For example, the score for 16, Place Value and Numeration, is the sum of .8 of the score for Writing Numbers (01) and .2 of the score for Inequalities (02). For 20, Problem Solving, the score is the sum of .6 of the score for Word Problems (12) and .4 of the score for Applications (13).

Grade 2

Results are shown in Table 16 which includes, for each objective, scores at times 1 and 8 and residual gain score. Mean scores are reported for label groups, for cluster groups and for all schools combined. Information about test results at all eight test times is provided by Webb and Nerenz (1980b).

At both test times 1 and 8, average scores for Writing Numbers (01) and for Measurement (11) were high; averages for Word Problems (12) were consistently low. Only for Writing Numbers was the average above .50

Table 15

Number of Items Contributing to Achievement Scores for the IGE/DMP Comparative Study

	Number of Items	
General Objective	Grade 2	Grade 5
01 Writing Numbers	16	
02 Inequalities	4	
16 Place Value and Numeration	20	
04 Addition/Subtraction	20	4
05 Multiplication		12
06 Division		8
17 Operations (Whole Numbers)	20	24
07 Fractions Concept	8	12
08 Fractions Computes		8
18 Fractions	8	20
09 Decimal Concept		4
10 Decimal Computes		12
19 Decimal Fractions		16
11 Measurement	4	
12 Word Problems	12	8
13 Applications	8	8
20 Problem Solving	20	16

Table 16

Achievement Results for the Grade 2 Schools

		Objective 01				Objective 02				Objective 16				Objective 04/17				Objective 07/18			
SCHOOL	CLUSTER	1	8	Change	Residual	1	8	Change	Residual	1	8	Change	Residual	1	8	Change	Residual	1	8	Change	Residual
IGE/DMP																					
440	T	.49	.78	+.29	+.07	.24	.57	+.33	-.06	.44	.74	+.30	+.07	.32	.44	+.12	-.08	.34	.54	+.20	+.02
593	P	.58	.87	+.29	+.07	.40	.84	+.44	+.14	.54	.86	+.32	+.07	.40	.78	+.38	+.14	.51	.56	+.05	-.00
Mean		.54	.83	+.29		.32	.70	+.38		.49	.80	+.31		.36	.61	+.25		.42	.55	+.13	
IGE/non-DMP																					
428	T	.48	.71	+.23	+.01	.31	.60	+.29	-.06	.45	.69	+.24	+.01	.32	.46	+.14	-.06	.41	.41	.00	-.13
421	-	.49	.71	+.22	-.00	.43	.78	+.35	+.06	.48	.72	+.28	+.00	.35	.53	+.18	-.04	.59	.67	+.08	+.08
333	P	.62	.77	+.15	-.07	.36	.79	+.43	+.10	.57	.77	+.20	-.06	.43	.61	+.18	-.08	.52	.53	+.01	-.04
Mean		.53	.73	+.20		.37	.72	+.35		.50	.73	+.23		.37	.53	+.16		.51	.54	+.03	
non-IGE/DMP																					
904	-	.51	.73	+.22	-.00	.41	.72	+.31	+.01	.49	.73	+.24	-.00	.31	.54	+.23	+.04	.30	.60	+.30	+.09
906	-	.62	.84	+.22	+.00	.27	.73	+.46	+.08	.55	.82	+.27	+.01	.37	.63	+.26	+.03	.38	.59	+.21	+.06
762	T	.45	.60	+.15	-.07	.41	.44	+.03	-.27	.44	.57	+.13	-.10	.24	.44	+.20	+.04	.38	.43	+.05	-.10
Mean		.53	.72	+.19		.36	.63	+.27		.49	.71	+.22		.31	.54	+.23		.35	.54	+.19	
Triplet mean		.47	.70	+.23		.32	.54	+.22		.44	.67	+.23		.29	.45	+.16		.38	.46	+.08	
Pair mean		.60	.82	+.22		.38	.82	+.44		.56	.82	+.26		.42	.70	+.28		.52	.54	+.02	
Grand mean		.53	.75	+.22		.35	.68	+.33		.50	.74	+.24		.34	.55	+.21		.43	.54	+.09	
Standard deviation		.07	.08			.07	.14			.05	.09			.06	.12			.10	.09		

Table 16 (continued)

SCHOOL	CLUSTER	Objective 11				Objective 12				Objective 13				Objective 20			
		1	8	Change	Residual	1	8	Change	Residual	1	8	Change	Residual	1	8	Change	Residual
IGE/DMP																	
440	T	.56	.57	+.01	-.16	.26	.48	+.22	+.13	.36	.46	+.10	-.00	.30	.47	+.17	+.10
593	P	.56	.75	+.19	+.02	.46	.71	+.25	+.05	.28	.62	+.34	+.23	.39	.67	+.28	+.10
Mean		.56	.66	+.10		.36	.60	+.24		.32	.54	+.22		.35	.57	+.22	
IGE/non-DMP																	
428	T	.88	.97	+.09	+.15	.31	.43	+.12	+.00	.28	.40	+.12	+.01	.30	.42	+.12	+.05
421	-	.25	.88	+.53	+.23	.33	.48	+.15	+.02	.46	.65	+.19	+.10	.38	.55	+.15	+.00
333	P	.70	.83	+.13	+.06	.34	.49	+.15	+.01	.43	.44	+.01	-.08	.38	.47	+.09	-.08
Mean		.61	.89	+.28		.33	.47	+.14		.39	.50	+.11		.35	.48	+.13	
non-IGE/DMP																	
904	-	.11	.80	+.69	+.19	.28	.33	+.05	-.05	.44	.54	+.10	+.01	.34	.41	+.07	-.05
906	-	.38	.32	-.06	-.37	.32	.47	+.15	+.02	.36	.30	-.06	-.16	.34	.40	+.06	-.06
762	T	.28	.53	+.25	-.13	.33	.28	-.05	-.18	.22	.24	+.02	-.10	.29	.26	-.03	-.08
Mean		.26	.55	+.29		.31	.36	+.05		.34	.36	+.02		.32	.36	+.04	
Triplet mean		.57	.69	+.12		.30	.40	+.10		.29	.37	+.08		.30	.38	+.08	
Pair mean		.63	.79	+.16		.40	.60	+.20		.36	.53	+.17		.39	.57	+.19	
Grand mean		.47	.71	+.24		.33	.46	+.13		.35	.46	+.11		.34	.46	+.22	
Standard deviation		.26	.22			.06	.13			.09	.14			.04	.12		

at test time 8. The smallest average gain, .09, was on Fractions (07); the largest, .33, on Inequalities.

In general, there was little variance for scores at test time 1 and greater variance at test time 8; variance did not change for objectives 01 and 07. On objective 11, Measurement, schools differed greatly at test time 1 and only slightly less at test time 8.

Scores for the pair of schools were consistently higher than the average and higher than scores for the triplet of schools. The triplet averaged below the mean except on objective 11, Measurement. The three non-IGE schools usually scored lowest of the label groups while the two groups of IGE schools alternately had the highest average.

In three schools--593, 421, and 904--residual gains were more positive than negative. School 593 residuals were consistently positive with a very large residual for Applications (13), indicated as very effective mathematics instructional program. School 421 had only one negative residual, -.04 for Addition/Subtraction (04) and a large positive residual for Measurement (11). School 904 also had only one negative residual, -.05 for Word Problems (12) and also a large positive residual for Measurement. Schools 440, 428, and 333 had a mix of positive and negative residuals, more negative than positive. School 906 also had a mix, but the large negative residual for Measurement, -.37, yielded a bad overall record. School 762 had only one positive residual, -.04 for Addition/Subtraction, suggesting that mathematics instruction at that school is ineffective.

Grade 5

Results are shown in Table 17 which includes, for each objective, scores at times 1 and 8 and residual gain score. Mean scores are reported for label groups, for cluster groups, and for all schools combined. Although only two of the schools in the triplet participated at Grade 5, Schools 440 and 428, the T designation is still used. Results for all eight test times are provided by Webb and Nerenz (1980b).

The most striking finding is the slight but consistent decline on Addition/Subtraction (04); only School 428 had a higher average at time 8 than at time 1. At both times 1 and 8, scores were highest for this objective. Scores were high at both times 1 and 8 for Multiplication (05). By time 8 the average score was above .50 for four additional objectives: Division (06), Fraction Concepts (07), Decimal Fraction Computing (10), and Word Problems (12). For the other three objectives--Fractions Computing (08), Decimal Concept (09), and Applications (13)--the average scores were low at time 1 and did not increase to a high level by time 8; however, the average gain for Fractions Computing (08) of .15 was greater than most.

There was generally little variance in scores at either time 1 or time 8 and, as a result, little change in variance between test times for most objectives. Variance decreased for Multiplication (05) and Division (06) and increased for Decimal Computing (10). At Grade 2, increased variance at time 8 had been typical.

Average scores for the pair of schools, from which only two schools participated, were higher than the average and higher than scores for the pair, except for Fractions Concept (07).

Table 17

Achievement Results for Grade 5 Schools

		Objective 04				Objective 05				Objective 06				Objective 17				Objective 07			
SCHOOLS	CLUSTER	1	8	Change	Residual	1	8	Change	Residual	1	8	Change	Residual	1	8	Change	Residual	1	8	Change	Residual
IGE/DMP																					
440	T	.83	.74	-.09	-.06	.62	.63	+.01	-.12	.31	.48	+.17	-.11	.55	.60	+.05	-.11	.50	.76	+.26	+.06
593	P	1.00	.96	-.04	+.02	.71	.86	+.15	+.11	.37	.82	+.45	+.21	.66	.86	+.20	+.12	.40	.58	+.18	-.03
Mean		.92	.85	-.07		.66	.74	+.08		.34	.65	+.31		.61	.73	+.12		.45	.67	+.22	
IGE/non-DMP																					
428	T	.78	.81	+.03	+.05	.58	.76	+.18	+.02	.36	.54	+.18	-.06	.54	.70	+.16	-.01	.31	.55	+.24	+.02
333	P	.92	.88	-.04	+.00	.79	.73	-.06	-.02	.60	.64	+.04	-.04	.75	.73	-.02	-.03	.40	.60	+.20	-.01
Mean		.85	.84	-.01		.68	.74	+.06		.48	.59	+.11		.64	.72	+.08		.36	.58	+.22	
non-IGE/DMP																					
905	-	.89	.85	-.04	-.00	.39	.76	+.37	+.02	.11	.52	+.41	-.01	.38	.70	+.32	+.04	.28	.48	+.20	-.02
906	-	.86	.82	-.04	-.00	.65	.74	+.09	-.01	.36	.60	+.24	-.00	.59	.71	+.12	-.00	.70	.85	+.15	-.02
Mean		.88	.84	-.04		.52	.75	+.23		.24	.56	+.32		.49	.71	+.22		.49	.66	+.17	
Triplet mean		.81	.78	-.03		.60	.70	+.10		.34	.51	+.17		.55	.65	+.20		.41	.66	+.25	
Pair mean		.96	.92	-.04		.75	.80	+.05		.49	.73	+.24		.71	.80	+.09		.40	.59	+.19	
Grand mean		.88	.84	-.04		.62	.75	+.13		.35	.60	+.25		.58	.72	+.14		.43	.64	+.21	
Standard deviation		.08	.07			.14	.07			.16	.12			.12	.08			.15	.14		

Table 17 (continued)

SCHOOL	CLUSTER	Objective 08				Objective 18				Objective 09				Objective 10				Objective 19			
		1	8	Change	Residual	1	8	Change	Residual	1	8	Change	Residual	1	8	Change	Residual	1	8	Change	Residual
IGE/DMP																					
440	T	.18	.40	+.22	+.07	.37	.62	+.25	+.07	.23	.42	+.19	+.09	.28	.43	+.15	-.03	.27	.43	+.16	-.00
593	P	.22	.29	+.07	-.08	.33	.46	+.13	-.05	.36	.43	+.07	+.02	.54	.84	+.30	+.15	.50	.74	+.24	+.12
Mean		.20	.34	+.14		.35	.54	+.19		.30	.42	+.12		.41	.64	+.23		.39	.59	+.20	
IGE/non-DMP																					
428	T	.11	.33	+.22	+.06	.23	.46	+.23	+.04	.25	.23	-.02	-.11	.44	.59	+.15	-.01	.39	.50	+.11	-.03
333	P	.19	.23	+.04	-.11	.32	.45	+.13	-.05	.33	.39	+.06	-.00	.47	.47	+.00	-.16	.44	.45	+.01	-.12
Mean		.15	.28	+.13		.28	.46	+.18		.29	.31	+.02		.46	.53	+.07		.42	.48	+.06	
non-IGE/DMP																					
905	-	.11	.26	+.15	-.01	.21	.39	+.18	-.01	.11	.26	+.15	+.00	.31	.42	+.11	-.07	.26	.38	+.12	-.05
906	-	.32	.51	+.19	+.06	.55	.71	+.16	-.00	.28	.36	+.08	-.00	.23	.54	+.31	+.12	.24	.50	+.26	+.09
Mean		.22	.38	+.16		.38	.55	+.17		.20	.31	+.11		.27	.48	+.21		.25	.44	+.19	
Triplet mean		.15	.37	+.22		.30	.54	+.24		.24	.33	+.11		.36	.51	+.15		.33	.47	+.14	
Pair mean		.21	.26	+.05		.33	.46	+.13		.35	.41	+.08		.51	.66	+.15		.47	.60	+.13	
Grand mean		.19	.34	+.15		.34	.52	+.18		.26	.35	+.09		.38	.55	+.17		.35	.50	+.15	
Standard deviation		.08	.10			.12	.12			.09	.08			.12	.16			.11	.13		

Table 17 (continued)

		Objective 12				Objective 13				Objective 20			
SCHOOL	CLUSTER	1	8	Change	Residual	1	8	Change	Residual	1	8	Change	Residual
IGE/DMP													
440	T	.39	.51	+.12	+.05	.17	.23	+.06	-.02	.28	.39	+.11	+.03
593	P	.50	.55	+.05	-.00	.23	.26	+.03	-.02	.37	.41	+.04	-.03
Mean		.44	.53	+.09		.20	.24	+.04		.33	.40	+.07	
IGE/non-DMP													
428	T	.28	.38	+.10	+.01	.20	.27	+.07	+.01	.24	.33	+.09	+.01
333	P	.48	.54	+.06	+.01	.23	.27	+.04	-.01	.36	.41	+.05	-.02
Mean		.38	.46	+.08		.22	.27	+.05		.30	.37	+.07	
non-IGE/DMP													
905	-	.43	.42	-.01	-.07	.07	.17	+.10	-.03	.25	.30	+.05	-.03
906	-	.58	.63	+.05	+.02	.15	.31	+.16	+.07	.37	.47	+.10	+.03
Mean		.50	.52	+.02		.11	.24	+.13		.31	.39	+.08	
Triplet mean		.34	.45	+.11		.19	.25	+.06		.26	.36	+.10	
Pair mean		.49	.55	+.06		.23	.27	+.04		.37	.41	+.04	
Grand mean		.44	.51	+.07		.18	.25	+.07		.31	.39	+.08	
Standard deviation		.10	.09			.06	.05			.06	.06		

Average scores for the pair of schools were higher than the overall averages and higher than scores for the triplet except for Fractions Concept (07) and its aggregate (18). The triplet averaged below the grand mean on all objectives except Applications (13). At Grade 2, the pair of schools had consistently averaged above the grand mean and above the average for the triplet.

The IGE/DMP schools had the highest average on six of the nine general objectives and three of the four aggregate objectives. On Multiplication (05) and Fraction Computing (08), the non-IGE/DMP schools averaged highest on Applications (13). Differences among the three groups of schools were small except for Decimal Computing (10) and its aggregate (19). At Grade 2, the non-IGE schools had had the lowest averages; School 762, which did not participate in the Grade 5 study, was the low scoring member of that Grade 2 label group.

Only Schools 593 and 906 had more positive than negative residual mean gain scores overall. The Grade 2 results for School 593 were consistently positive, while School 906 had predominantly negative results. At School 493 instruction was particularly effective for the general objectives contributing to aggregates for Operations (17) and Decimal Fractions (19). Schools 333 and 905 had the most consistently negative residuals. Instruction at School 333, which had only two very small positive residuals appears particularly ineffective.

VII

Predictive Results

In this chapter, results for each of the four aggregate objectives in mathematics are discussed in relation to time and means of instruction. The emphasis is on identifying instructional patterns that are particularly effective in raising children's achievement.

GRADE 2

On Objective 16, Place Value and Numeration, students in Schools 440, 593, and 906 made above average achievement gains (Table 18). Students were observed to be engaged more hours at these three schools than at the other five. Hours engaged reflects the emphasis on this objective at School 440, where over one-third of the mathematics instructional time was allocated to place value and numeration. Although only half as much of the mathematics time was allocated to this objective at Schools 593 and 906, the high emphasis on mathematics at these schools, indicated by the estimated hours of mathematics instruction each week, resulted in a large number of hours of instruction on this objective. As a group, these three schools showed no distinctive pattern of instruction.

Although addition, subtraction, and multiplication were included for instruction in Objective 17, Operations, only addition and subtraction were tested and very little was allocated to multiplication at any of the schools (see Table 5). At most schools, addition and subtraction of whole numbers is the primary focus of the second-grade mathematics curriculum; only at

Table 18

Data Summary for Objective 16, Place Value and Numeration, Grade 2

SCHOOL	Demography	Use of DMP	Use of IPM	Est. hrs/wk	Hours alloc.	% alloc.	Engaged		Grouping			Materials			Interactions		Achievement			
							Hrs.	%	Indiv.	Small	Lg.	Pop.	Manip.	Print	Stud.	Tchr.	1	8	Ch.	Resid.
IGE/DMP																				
440	2	9.00	52.75	2.4	163.4	34	13.33	71	8.58	1.86	8.31	13.38	7.89	.00	.71	4.80	.44	.74	+.30	+.07
593	6	10.00	39.00	3.7	121.6	16	10.59	77	9.90	.66	3.15	5.39	.00	8.25	1.41	.91	.54	.86	+.32	+.07
IGE/non-DMP																				
428	2	0.00	71.75	1.9	42.7	15	6.03	84	4.50	.12	2.54	6.71	.18	.07	.36	.19	.45	.69	+.24	+.01
421	5	0.00	80.00	2.2	3.3	1	1.84	40	3.87	.00	.68	4.04	.00	.00	.16	.10	.48	.72	+.24	+.00
333	6	0.00	58.00	1.6	12.5	4	2.53	90	2.62	.00	.18	2.13	.00	2.33	.38	.73	.57	.77	+.20	-.06
non-IGE/DMP																				
904	2	9.00	46.00	2.0	48.6	16	5.70	32	4.85	.18	5.87	9.91	.00	7.93	.60	1.80	.49	.73	+.24	-.00
906	5	8.40[a]	--	3.7	93.0	17	17.70	72	7.09	6.39	11.25	19.19	19.67	5.66	3.16	4.81	.55	.82	+.27	+.01
762	1	10.00	77.00	2.4	91.1	12	6.25	58	8.91	.00	1.87	10.13	.29	.00	.78	.36	.44	.57	+.13	-.10
Mean	3.63	5.71		2.5	72.0	14.4	8.01	68	6.29	1.15	4.23	8.86	3.50	3.03	.95	1.71	.50	.74	+.24	
Standard deviation	2.07	4.78			55.1	9.9	5.49	16.8	2.68	2.21	3.91	5.54	7.08	3.68	.97	1.98	.05	.09		

[a] Average of scores for DMP use at 5 other DMP schools.

Schools 440 and 906 was less than 40% of the mathematics instructional time allocated to operations. Initial scores were above average at School 593 as well as at Schools 421, 333, and 906 (Table 19). At Schools 593 and 906, achievement gains were above average; at Schools 421 and 333, below. At Schools 421 and 333, students worked individually over 80% of the time. Individual work occurred a smaller proportion of the observed time at Schools 593 and 906 where large groups were more frequently observed. At School 906, extensive use of small groups was also observed. Paper-and-pencil materials, worksheets, were in use about half the time at Schools 593 and 521 and nearly 90% of the time at Schools 333 and 906; both Schools 593 and 906 used additional materials--primarily printed materials at School 593 and entirely manipulatives at School 906--for nearly the same amount of time worksheets were in use. In addition, there were more interactions at Schools 593 and 906.

Instruction in fraction concepts were observed at only six of the eight schools; at none of these schools was the number of hours large. Only a small proportion of the allocated time was scheduled for Objective 18, Fractions. These data are insufficient for detailed disucssion. Note, however, that the two schools in which students made substantial gains, Schools 440 and 904, were the two in which manipulatives were in use for a large proportion of the available time (Table 20).

Only in the five DMP schools was a substantial proportion of time formally allocated to Objective 20, Problem Solving, and only in those schools were instruction in problem solving observed. The achievement gains at Schools 428, 421, and 333 suggest that problem solving is an

Table 19

Data Summary for Objective 17, Operations, Grade 2

	Allocated		Engaged		Grouping			Materials			Interactions		Achievement			
SCHOOL	Hrs.	%	Hrs.	%	Indiv.	Small	Lg.	Pop.	Manip.	Print	Stud.	Tchr.	1	8	Ch.	Resid
IGE/DMP																
440	97.2	20	11.44	66	6.24	2.16	9.05	13.60	7.64	.00	1.23	3.74	.32	.44	+.12	-.08
593	312.3	42	46.50	71	41.47	6.09	17.59	34.96	4.23	21.00	7.89	6.07	.40	.78	+.38	+.14
IGE/non-DMP																
428	141.1	50	13.93	82	12.91	.70	3.21	14.81	2.14	.00	1.32	1.53	.32	.46	+.14	-.06
421	206.1	45	13.09	59	17.91	1.95	1.86	11.11	2.73	.00	1.90	1.29	.35	.53	+.18	-.04
333	202.5	68	30.05	74	36.35	2.09	2.29	35.80	.11	15.73	3.87	2.07	.43	.61	+.18	-.08
non-IGE/DMP																
904	130.8	44	17.56	76	21.13	.16	1.81	21.59	.00	6.33	.89	1.16	.31	.54	+.23	+.04
906	158.3	29	13.08	64	6.55	4.79	9.22	18.03	16.69	.00	1.72	2.59	.37	.63	+.26	+.03
762	295.4	40	31.44	65	34.84	2.22	11.34	44.65	9.05	.30	3.23	4.78	.24	.44	+.20	+.04
Mean	230.5	42.3	21.14	69.6	22.18	2.52	7.07	24.32	5.32	5.42	2.76	2.90	.34	.55	+.21	
Standard deviation	165.7	14.2	12.59	7.5	13.82	1.98	5.71	12.45	5.63	8.40	2.31	1.80	.06	.12		

Table 20

Data Summary for Objective 18, Fractions, Grade 2

	Allocated		Engaged		Grouping			Materials			Interactions		Achievement			
SCHOOL	Hrs.	%	Hrs.	%	Indiv.	Small	Lg.	Pop.	Manip.	Print	Stud.	Tchr.	1	8	Ch.	Resid.
IGE/DMP																
440	5.8	1	.87	79	.75	.06	.29	1.10	.87	.00	.06	.29	.34	.54	+.20	+.02
593	12.6	2	3.53	65	4.92	.25	.29	4.83	.07	5.00	.06	.00	.51	.56	+.05	-.00
IGE/non-DMP																
428	2.7	1											.41	.41	+.00	-.13
421	32.6	7	1.48	45	1.52	1.30	.44	2.26	.38	.00	.18	1.23	.59	.67	+.08	+.08
333	14.0	5	2.26	77	1.19	.00	1.75	1.13	.00	2.93	.00	1.23	.52	.53	+.01	-.04
non-IGE/DMP																
904	0.0	0	6.17	77	5.39	.32	2.33	3.39	3.91	.00	.56	1.00	.30	.60	+.30	+.09
906	58.0	11											.38	.59	+.21	+.06
762	99.5	14	2.36	66	.15	.00	3.44	3.35	.50	.00	.00	.96	.38	.43	+.05	-.10
Mean (6 schools)	27.41	4.83	2.78	68.17	1.45	.32	1.42	2.68	.96	1.32	.14	.79	.44	.56	+.12	
Standard deviation	36.99	5.19	1.89	12.84	1.79	.50	1.31	1.46	1.48	2.15	.21	.52	.12	.08		
Mean (8 schools)	27.87	5.00											.43	.54	+.11	
Standard deviation	36.60	5.02											.10	.09		

Table 21

Data Summary for Objective 20, Problem Solving, Grade 2

	Allocated		Engaged		Grouping			Materials			Interactions		Achievements			
SCHOOL	Hrs.	%	Hrs.	%	Indiv.	Small	Lg.	Pop.	Manip.	Print	Stud.	Tchr.	1	8	Ch.	Resid.
IGE/DMP																
440	121.3	25	6.22	64	2.98	2.01	4.65	8.05	4.89	.00	1.10	2.16	.30	.47	+.17	+.10
593	149.1	20	7.89	77	5.18	.00	5.12	3.14	.00	7.38	.58	2.00	.39	.67	+.28	+.10
IGE/non-DMP																
428	7.4	3											.30	.42	+.12	+.05
421	12.7	3											.38	.55	+.17	+.00
333	00.0	0											.38	.47	+.09	-.08
non-IGE/DMP																
904	62.3	20	13.00	80	1.40	.17	14.65	15.10	.00	5.01	.93	3.19	.34	.41	+.07	-.05
906	228.2	42	22.57	66	13.37	5.97	14.66	27.84	27.01	2.83	5.03	7.84	.34	.40	+.06	-.00
762	121.1	17	8.31	68	5.64	.00	6.53	11.50	3.32	.41	1.27	2.48	.29	.26	-.03	-.08
Mean (6 schools)	136.4	24.8	11.60	71	5.71	1.63	9.12	13.13	7.04	3.13	1.78	3.53	.33	.44	+.11	
Standard deviation	60.29	10.03	6.63	7.07	4.61	2.57	5.10	9.33	11.36	3.12	1.83	2.45	.04	.15		
Mean (8 schools)	87.76	16.3											.34	.46	+.12	
Standard deviation	81.21	14.06											.04	.12		

integral part of instruction on other mathematics of objectives (Table 21). Achievement gains were low for all three non-IGE/DMP schools, particularly so in School 906 where over 50% of the mathematics instructional time was allocated to problem solving. The instructional pattern in this school was not different from the effective patterns at Schools 440 and 593. It seems possible that both allocations and observations did not include a clear distinction between the operations of addition and subtraction and the application of those skills in problem solving.

GRADE 5

At Schools 440 and 333, where achievement on Objective 17, Operations, changed very little from time 1 to time 8, the overall rate of materials use was much lower than at other schools (Table 22). At Grade 5, the identification of particularly effective instructional patterns is very difficult. For example, at School 905 instruction in operations was very successful; the achievement gain was more than double the average gain and was sufficient to bring the time 8 score very close to the average. At School 906, the instructional pattern observed was nearly identical to that observed at School 905; however, at School 906, the achievement gain was slightly less than average.

As at Grade 2, but less dramatically, the use of manipulatives seems to enhance achievement on Objective 18, Fractions (Table 23). The only other apparent effect is of relative emphasis on fractions in the overall mathematics curriculum as indicated by proportion of allocated time.

Only at School 593, was instruction in Objective 19, Decimal Fractions, a major portion of the fifth grade mathematics curriculum (Table 24).

Table 22

Data Summary for Objective 17, Operations, Grade 5

SCHOOL	Demography	Use of DMP	Use of IPM	Est. hrs/wk	Allocated Hrs.	Allocated %	Engaged Hrs.	Engaged %	Grouping Indiv.	Grouping Small	Grouping Lg.	Materials Pop.	Materials Manip.	Materials Print	Interactions Stud.	Interactions Tchr.	Achievements 1	Achievements 8	Achievements Ch.	Achievements Resid.
IGE/DMP																				
440	2	9.00	52.75	3.6	245.1	33	23.22	63	28.73	2.29	5.84	12.62	2.67	2.50	1.32	4.57	.55	.60	+.05	-.11
593	6	10.00	39.00	2.8	174.9	32	15.66	90	12.09	.00	5.29	16.19	.00	10.14	1.23	3.10	.66	.86	+.20	+.12
IGE/non-DMP																				
428	2	.00	71.75	3.3	156.7	32	24.47	79	18.54	1.42	11.20	28.53	1.55	9.86	2.64	1.64	.54	.70	+.16	-.01
333	6	.00	58.00	3.4	116.0	23	12.74	73	17.44	.00	.00	17.21	.00	.95	.15	.17	.75	.73	-.02	-.03
non-IGE/DMP																				
905	2	4.00	17.00	3.1	232.0	49	31.94	79	31.11	3.58	4.74	36.32	1.21	26.55	2.99	2.63	.38	.70	+.32	+.04
906	5	8.40[a]	--	3.4	314.6	46	28.65	70	31.57	6.99	2.45	38.82	2.43	26.57	4.46	2.61	.59	.71	+.12	-.01
Mean		5.11		3.3	206.55	36	22.78	76	23.25	2.38	4.92	24.95	1.31	12.76	2.13	2.45	.58	.72	+.14	
Standard deviation		4.45		.28	71.41	9.79	7.39	9.24	8.26	2.64	3.76	11.16	1.15	11.32	1.54	1.47	.12	.08		

[a] Average of scores for DMP use at 5 other DMP schools.

Table 23

Data Summary for Objective 18, Fractions, Grade 5

	Allocated		Engaged		Grouping			Materials			Interactions		Achievements			
SCHOOL	Hrs.	%	Hrs.	%	Indiv.	Small	Lg.	Pop.	Manip.	Print	Stud.	Tchr.	1	8	Ch.	Resid.
IGE/DMP																
440	349.4	47	24.68	58	24.23	1.27	17.30	37.50	2.74	3.84	1.80	9.13	.37	.62	+.25	+.07
593	147.8	27	20.65	80	5.02	.00	20.77	21.25	.00	12.21	3.04	10.49	.33	.46	+.13	-.05
IGE/non-DMP																
428	156.9	32	19.30	89	7.84	.70	13.16	18.86	.70	11.30	2.31	3.84	.23	.46	+.23	+.04
333	139.3	27	9.98	77	12.31	.65	.00	12.21	.00	6.29	.94	.37	.32	.45	+.13	-.05
non-IGE/DMP																
905	170.6	36	14.81	66	18.57	2.72	1.00	18.55	.40	15.02	1.88	1.14	.21	.39	+.18	-.01
906	219.5	32	19.56	66	22.11	3.80	3.92	28.95	.00	16.69	2.19	2.67	.55	.71	+.16	-.00
Mean	197.3	34	18.16	73	15.01	1.52	9.36	22.89	.64	10.89	2.03	4.61	.34	.52	+.18	
Standard deviation	79.73	7.45	5.10	11.34	7.83	1.45	8.89	8.97	1.07	4.97	.69	4.23	.12	.12		

Table 24

Data Summary for Objective 19, Decimal Fractions, Grade 5

	Allocated		Engaged		Grouping				Materials		Interactions		Achievement			
SCHOOL	Hrs.	%	Hrs.	%	Indiv.	Small	Lg.	Pop.	Manip.	Print	Stud.	Tchr.	1	8	Ch.	Resid.
IGE/DMP																
440	6.7	1											.27	.43	+.16	-.00
593	191.5	35	15.26	79	8.20	.00	11.25	12.20	.00	14.37	1.66	5.11	.50	.74	+.24	+.12
IGE/non-DMP																
428	55.4	11	11.39	88	7.11	.18	5.72	10.76	.40	7.75	1.97	2.64	.39	.50	+.11	-.03
333	17.8	3	3.31	81	4.09	.00	.00	4.09	.00	.77	.29	.10	.44	.45	+.01	-.12
non-IGE/DMP																
905	15.0	3	1.94	76	1.82	.11	.61	1.78	.00	1.41	.10	.55	.26	.38	+.12	-.05
906	47.6	7	4.30	64	5.36	.50	.89	6.41	.93	2.63	.79	.60	.24	.50	+.26	+.09
Mean (5 schools)	65.5	12	7.24	78	5.32	.16	3.69	7.05	.27	5.39	.96	1.8	.37	.51	+.14	
Standard deviation	72.67	13.39	5.78	8.79	2.51	.21	4.80	4.39	.41	5.72	.83	2.09	.11	.14		
Mean (6 schools)	55.7	10											.35	.50	+.15	
Standard deviation	69.28	12.76											.11	.13		

Achievement gains were very large at this school and at School 906 although achievement levels at the two schools were very different.

At no school was instruction in Objective 20, Problem Solving, a significant portion of the mathematics instructional program, as shown by percentage of allocated time (Table 25). At all schools, achievement gains were small from an initial level that was uniformly low. Instructional patterns were very similar at the three schools where problem solving instruction was observed.

Table 25

Data Summary for Objective 20, Problem Solving

	Allocated		Engaged		Grouping			Materials			Interactions		Achievements			
SCHOOL	Hrs.	%	Hrs.	%	Indiv.	Small	Lg.	Pop.	Manip.	Print	Stud.	Tchr.	1	8	Ch.	Resid
IGE/DMP																
440	34.1	5	4.06	65	4.67	.06	1.50	5.90	.00	3.05	.12	.93	.28	.39	+.11	+.03
593	0.0	0											.37	.41	+.04	-.03
IGE/non-DMP																
428	26.1	5											.24	.33	+.09	+.01
333	28.8	6	2.72	82	3.30	.00	.00	3.13	.00	1.82	.27	.29	.36	.41	+.05	-.02
non-IGE/DMP																
905	22.3	5											.25	.30	+.05	-.03
906	20.6	3	4.77	62	3.35	1.16	.27	4.77	.00	2.55	.49	.20	.37	.47	+.10	+.03
Mean (3 schools)	27.8	5	3.24	70	3.77	.41	.59	4.60	.00	2.47	.29	.47	.34	.42	+.09	
Standard deviation	6.80	1.53	.72	10.79	.78	.65	.80	1.39	.00	.62	.19	.40	.05	.04		
Mean (6 schools)	22.0	4											.31	.39	+.08	
Standard deviation	11.79	2.19											.06	.06		

VIII

Summary

The data presented in this report are from one of five studies conducted as a part of Phase IV of the IGE Evaluation Study. The four primary purposes of the Phase IV Evaluation Project (p. 8) reflect on our attempt to describe in considerable detail the actual operating characteristics of a sample of schools that were using the curriculum materials designed to be compatible with IGE. This comparative study was designed to provide information related to the fourth purpose, which was for the mathematics program Developing Mathematical Processes (DMP), to contrast two situations.

--IGE schools using the program with non-IGE schools using the program

--IGE schools using the program with IGE schools using alternate programs

The contrast was made on the variables of pupil outcomes, instructional time, and means of instruction. From this contrast, we expected to be able to answer three specific questions.

1. What are the effects on mathematics instruction of using the DMP mathematics program in an IGE and a non-IGE school environment?
2. What are the effects on mathematics instruction of using DMP and using other mathematics programs in the IGE school environment?

3. What are the relationships between the variables presented in the Phase IV model? (See Figure 2)

General Findings

Before we attempt to summarize the findings with respect to the specific questions above, an overall picture of mathematics instruction, both at Grade 2 and Grade 5 in this sample of schools, is warranted. The data presented in the previous chapters in some sense describe 14 quite different instructional settings (eight schools, second grade at all eight and fifth grade at six of them). It appears that each of the 14 learning environments is unique. The demography of the school, the way in which it is organized, the degree of implementation of various components of IGE, the way in which time is used in classrooms, the way in which instruction is actually carried out, and the level of achievement on different objectives present an interesting descriptive picture about each learning environment. However, there is little common from situation to situation. For example, using the background variables, we were able to form clusters of schools. The first was a pair of schools--both IGE schools, one using DMP, one not; and a non-IGE school using DMP. Also there were three isolated cases. This clustering showed moderate relationship dependent upon self-report data about implementation of multiaged units; however, it did not include the operational use of the instructional programming model within those units. When we looked at how time was actually allocated and spent on various objectives in mathematics and the way in which instruction was carried out, the clusters did not demonstrate a consistent pattern related to instruction. Thus, the first conclusion of the study is that there is no obvious pattern by which the different learning environments at each grade level can be appropriately grouped; one cannot confidently argue that any two classrooms (or units) operated in the same way.

In spite of this first conclusion, some statements can be made about mathematics instruction. At second grade, although there is considerable variation in amount of allocated time to different objectives, it is clear that work on the operations of addition and subtraction comprises the largest percentage of allocated time in seven of the eight classrooms. The remaining time is distributed somewhat unevenly over the other general objectives. Instruction tends to be either carried out at an individual leve. or at a large group level. Print materials are predominently used. There are relatively few interactions in all classes.

Similarly for Grade 5, the emphasis is on operations and fractions with little consistent instruction on any other objectives. Instruction is predominently individual. Print materials are most often used, regardless of setting or instructional objective.

At both grades, if time is reasonably allocated to objectives, then students' performance does improve. Also, if little time is allocated to instruction (such as fractions at second grade), then little change in achievement is shown.

Specific Findings

Research Question 1. What are the effects on mathematics instruction of using the DMP mathematics program in an IGE setting and a non-IGE school setting?

Whether a school calls itself IGE or not is not an important variable; the label difference is not a good indicator of operating differences in the schools. The instructional programming model is the key here. It is what good teachers follow anyway. This study is not a good test of use of the instructional programming model.

Research Question 2. What are the effects on mathematics instruction of using DMP and using other mathematics programs in the IGE school environment?

At Grade 2, the non-DMP users did not allocate time to solving word problems. This objective is emphasized in DMP. The differences in problem-solving performance between DMP and non-DMP groups clearly favors the use of DMP. Similar differences at Grade 5 were not found since little time was allocated to problem solving in any class. A second unanticipated finding was that there was no pattern of differences favoring the non-DMP users on the operations of addition and subtraction. Since DMP does not emphasize mastery of addition and subtraction until the beginning of third grade, the activities at Grade 2 are designed to develop the conceptual underlying ideas for those skills. Thus, the amount of allocated time for addition and subtraction should have been less at DMP schools, and performance, in turn, should have been lower. Neither was the case. DMP users seem to have modified the program so that the time allocated to computation was similar to that allocated by non-DMP users. For all schools, we believe an inordinant amount of time is spent on addition and subtraction skills at Grade 2, with not enough time allocated to other important parts of mathematics. Thus, our second conclusion is that the differences between DMP users and DMP non-users are not as striking as expected. In this study, we are not in the position to examine how and why teachers modified the program to fit the traditional pattern of instruction; this seems to be the pattern which has emerged at both second and fifth grade.

Research Question 3. What are the relationships between the variables presented in the model for the evaluation?

The overall realtionship as proposed in the model cannot be statistically examined in the study. Many of the variables are highly correlated and the sample of schools is very small. It was hoped that an overall pattern could be seen with respect to the variables; this is not the case. However, there are some hints of relationships that warrant attention in later studies.

First, a lower limit for allocated time is needed to increase achievement in any areas, but the relationship of allocated time to performance is not linear. For example, at Grade 2 the variability in time allocated to computation is not related to achievement since all spend a lot of time. In fact, some schools are probably spending too much time for the relative pay off.

Second, individualized instruction with children working independently on worksheets is detrimental. For example, in School 333 at Grade 5, where this is the only way in which instruction is carried out, the approach produces low achievement.

Third, for some of the objectives (fractions, place value, and numeration, for example), the use of manipulative materials as a means of instruction is very effective for improving achievement.

Fourth, interactions of children with other children or with teachers are needed. Again, in Grade 5 at School 333, there are almost no interactions and the children's performance is disappointing.

Limitations

Before concluding this chapter, let me remind the reader of three basic limitations of this study. First, these data come from a small sample of schools. No claim can be made that they are representative either of DMP users or of IGE schools. Second, the variables examined in this study are the variables of interest in the IGE model. The data associated with these variables are highly correlated. For example, allocated time is highly correlated with engaged time. Analysis on small sets of related data could not be done with meaning and has not been attempted; the relationships discussed above must be considered suspect. Third, there are four different sets of data on these classrooms. The background data were provided by teachers and administrators from self-report questionnaires; these data provide information about school-wide patterns. The class log data was provided by teachers on how time was spent for one group of children in their classrooms. Observations in those classrooms were often on different sets of students as regrouping took place. Finally, the achievement data came from all students; it provides information about that total population. These two data sets provide different estimates of class variables. The appropriateness of the sources for predicting what the group is like has not been demonstrated.

Conclusions

On reflection, it is now clear that selecting schools because they call themselves "IGE schools" or "DMP users" is not adequate for testing either the use of the instructional programming model, the key feature of IGE, or the use of the particular instructional materials, Developing Mathematical Processes. For both, a school's use of the label is no guarantee that the ideas associated with either the instructional programming model or DMP are being followed. In fact, what seems to be the case is that the underlying conceptual ideas which guided the developers of IGE or DMP are not clearly reflected in the way in which instruction is carried out. This conclusion may be an artifact of the sample chosen or it may be more pervasive. In fact, it may be unreasonable to expect people to change as much as was expected in an IGE/DMP setting. For example, the teacher using DMP materials without using the manipulatives or small groups and passing out only worksheets is hardly using the program. Or, an IGE school in which teachers do not regroup students periodically according to need does not provide a good test of the instructional programming model.

It should be apparent that we have not reported all of the data gathered in this study. It would have been better to gather less data from more schools. What we have is an extensive description of 14 different learning environments, not one of which reflects in a clear way the ideas underlying IGE or DMP. In fact, the strongest claim that can be made is that each class has its own characteristics. This diversity is not a function of the type of community, of the way in which instruction is carried out, of whether a school calls itself IGE, or whether they use a particular mathematics program.

What can be said in conclusion is that one needs to spend a minimum amount of time on an objective to produce achievement; there needs to be some teacher/pupil interaction; instruction best proceeds from the concrete to the abstract; and time should be allocated to solving word problems.

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